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ABSTRACT

GRADES OR AGES: K-12. SUBJECT MATTER: Aerospace education. ORGANIZATION AND PHYSICAL APPEARANCE: The guide is divided into two main sections, one each for primary and secondary levels. Each section is further subdivided into several parts. The guide is printed and staple bound with a paper cover. OBJECTIVES AND ACTIVITIES: Activities at each level are integrated into other parts of the curriculum--language arts, arithmetic, music, social studies, science, and art at the primary level and home economics, social studies, earth science, life science, and industrial arts at the secondary level. Suggested activities are specific and varied, with detailed descriptions given for laboratory experiments. Each group of activities is preceded by a short list of objectives. The guide also contains a complete sequence of detailed lesson plans for a one-year private pilot ground school course for grades 10, 11, or 12. INSTRUCTIONAL MATERIALS: Each lesson plan for the private pilot ground school course includes a list of materials needed. Some of the other units list films to be used in the unit. The guide also contains a bibliography of teacher and student references and a list of films, charts and pictures, pamphlets, and supplies. STUDENT ASSESSMENT: No mention. (RT)

A Curriculum Guide for Aerospace Education

(K-12)

Prepared by the
State Air Education Committee
and the
Members of the Aerospace Education Workshop
and the
Oklahoma Curriculum Improvement Commission
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Clifford Wright, Executive Secretary
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in cooperation with
The Oklahoma Aeronautics Commission
William J. Cunningham, Chairman
Keith Lutz, Director

OKLAHOMA STATE DEPARTMENT OF EDUCATION
Scott Tuxhorn, Superintendent
1970

STATE OF OKLAHOMA
OFFICE OF THE GOVERNOR

OKLAHOMA CITY

DEWEY F. BARTLETT
GOVERNOR

In 1969 the State Air Education Committee, chaired by the State Superintendent of Public Instruction, was appointed to study the Oklahoma educational program in aviation and aerospace. As a result this committee held an Aerospace Education Workshop in the summer of 1969 for the teachers of Oklahoma. The participants of the Aerospace Education Workshop developed this material for the first Aerospace Education Curriculum Guide for grades kindergarten through twelve. Another Aerospace Education Workshop is planned for the summer of 1970 when a further revision of this guide will be made.

The aerospace industry is the third largest and fastest growing industry in Oklahoma. Many of our young people will choose their careers in this dynamic field and, I hope, earn their living in this great state.

This Aerospace Education Curriculum Guide is a step forward for our educators. This material will assist them with their many students who have an interest in this area.

As Governor of Oklahoma, I urge all educators in the State of Oklahoma to include aerospace education at every academic level and in every field of study with the opening of our schools in September, 1970.

We are grateful to the leadership shown by the State Department of Education, the Oklahoma Aeronautics Commission, and to all of those who have made contributions to this booklet.

Dewey Bartlett

Dewey F. Bartlett
Governor

FOREWORD

The special Air Education Committee appointed in 1968 by Governor Dewey F. Bartlett resulted in the Oklahoma Aerospace Education Workshop in the summer of 1969. This guide was prepared by the teachers participating in the workshop, consultants, and other educators and is designed to assist teachers in teaching aerospace education. Its purpose is to assist teachers to incorporate aviation and space matters in their daily teaching so that their students will become more aware of these dynamic industries.

We all recognize there is a growing national interest in capitalizing on the motivation that aviation and aerospace studies provide for students as well as teachers. As one who has participated actively in both aviation and aviation education, I commend the Oklahoma educators at the local and state level for the imagination and initiative in developing this curriculum guide in Aerospace Education.

The State Department of Education gratefully acknowledges the contributions of the State Committee and Subcommittees of the Oklahoma Curriculum Improvement Commission, and especially to the Oklahoma Aeronautics Commission for their support of this project.

The State Department of Education takes pride, in behalf of all those who have had a share in producing it, in offering this guide to the teachers of the State of Oklahoma for reference, and for suggestions on how they may enhance their effectiveness in the fine art of teaching. I am confident that the excellent materials contained in this booklet will be of great value to all schools of the state that seek to use them to suit local needs objectively and professionally.

Scott Tuxhorn

State Superintendent of Public Instruction

ACKNOWLEDGMENTS

1970

OKLAHOMA AEROSPACE EDUCATION WORKSHOP

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Special thanks is hereby given to the Legislature of Oklahoma for their cooperation and support of the Aerospace Education Program.

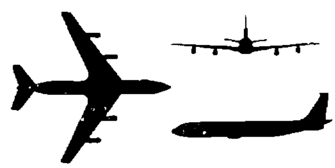
TABLE OF CONTENTS


EDUCATION!
HISTORY
EXCITEMENT
TRAVEL
WHO, ME FLY?
N8000W
FAMILY FLYING FUN

TO THE TEACHER:

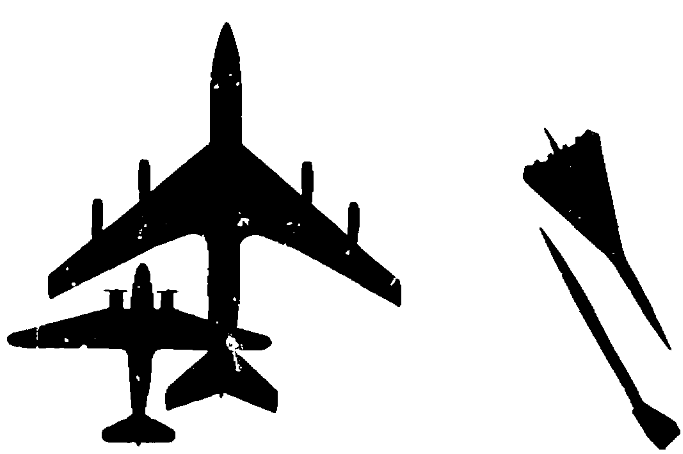
All of us recognize the great interest that our students have in aviation and space activities. The motivation to learn more in this field, and to feel a part of this exciting activity, is already high among our youth. The purpose of this book is to provide information and to help the teacher who wants to accomplish the goals of education. The teacher wants to insure that the student's learning activities are both effective and efficient. The materials available are of such variety and from such diverse sources that obtaining and evaluating these requires excessive amounts of time and effort for the interested teacher.

This curriculum guide contains listings and examples of the many current publications and other resources available, and has classified them according to subject matter and grade level. The teacher who wants to establish an aerospace oriented course of study will find many examples here of courses that have been developed in recent years and which can be used as models. The teacher who desires to incorporate a unit on aviation or space can find in this guide many illustrations graded for applicability to specific age groups.



WHAT IS AEROSPACE EDUCATION?

Aerospace education is that branch of general education concerned with communicating knowledge, skills, and attitudes about aerospace activities and the total impact of air and space vehicles upon society. It must be distinguished from those branches of special education known as aeronautical and/or astronautical education which are concerned with training specialized aerospace workers.



INTRODUCTION

We feel that the public schools in the State of Oklahoma should make every effort to include aerospace education in every subject.

It is recommended that high schools introduce a separate course in aerospace education in addition to integrating it into all subject matter areas.

PHILOSOPHY

This program should be implemented in such a manner that the teacher has the freedom to utilize that amount of time and content deemed expedient or important in this area.

It is further believed that the teacher should have a pragmatic awareness of the subtle relationships and nuances between aerospace education and the total curriculum.

It is desirable that the program include grades K-12.

Finally, it is recommended that the content utilize all of the materials, aids, and resources as possible.

GENERAL OBJECTIVES

1. To develop an awareness of the needs and implications of aerospace education and its impact on our society.
2. To seek to integrate aerospace education with all classroom activities.
3. To motivate and stimulate pupils' interest in and understanding of the scientific and social advancements being made by mankind as a result of aerospace research and development.
4. To develop the abilities to speak and write about aerospace education in a meaningful manner.
5. To motivate the child's interest in aerospace education through all subject matter areas.
6. To create an interest and appreciation on the part of the child for aerospace literature and related materials, and to assist him in the interpretation of these.
7. To prepare all students so that they may participate in a society strongly influenced by the growth of aviation and space exploration.
8. To furnish all students opportunities for career exploration in aerospace.
9. To provide a flight experience for all students.
10. To provide some students aviation ground school and/or vocational and technical training in aviation skills.
11. To establish a collection of aerospace materials available to both school and community.

Aerospace Activities
Primary Level

AEROSPACE ACTIVITIES

Primary Level

Content Area

Language Arts

Activities

Experience Chart

1. From class dictation write simple chart stories about the planets.
2. From class dictation write simple chart stories about the satellites.
3. From class dictation write simple chart stories about the solar system.
4. From class dictation write simple chart stories about the moon.
5. From class dictation write simple chart stories about the moon, the solar system, and the stars.
6. From class dictation write simple chart stories about the United States' space program.
7. From class dictation write simple chart stories about airplanes.
8. From class dictation write simple chart stories about a trip on an airplane.
9. From class dictation write simple chart stories about air and gravity.
10. From class dictation write simple chart stories about a trip to the moon.
11. From class dictation write simple chart stories about why I would like to go to the moon.
12. From class dictation write simple chart stories about how I would feel in space.

Written

1. Write stories about the solar system.
2. Write stories of space travel.
3. Write stories of the United States' space program using pictures.
4. Write stories about the lives of the astronauts.
5. Write stories about how an airplane flies.

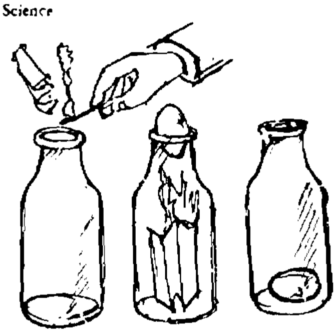
Dramatic Plays

1. Dramatize the launching of a satellite.
2. Dramatize a trip on an airplane.
3. Dramatize a trip in space.
4. Dramatize the story of a space pilot.
5. Dramatize the life of a space traveler.

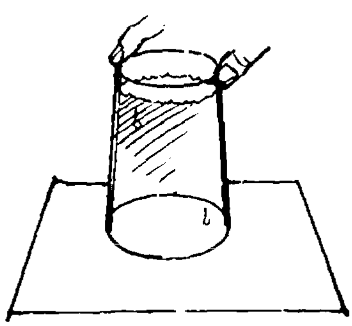
Reading

1. Develop a picture dictionary of aerospace vocabulary.

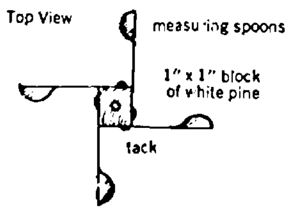
Content Area	Activities
Arithmetic	Number Experiences 1. Compare the size of the planets to the size of known objects. 2. Countdown the launching of a satellite. 3. Compare the size of the planets to the size of the earth.
Music	Rhythm 1. Imitate the feeling of floating in space. 2. Imitate the movements of an airplane with music background. 3. Imitate the different kinds of airplanes with music background.
Social Studies	Social Studies 1. Have children bring pictures in the news about the astronauts.
Science	Science

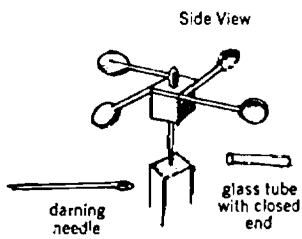


1. Place a hard-boiled egg (shell removed) on top of an empty quart milk bottle. The egg cannot be pushed through the bottle without exerting force. Remove the egg and insert a flaming torch made from a piece of rolled-up paper into the milk bottle. Quickly place the egg back on top of the bottle. Why did this happen?
2. Fill a glass to the top with water. Place a card on the top of the glass larger than the diameter of the glass. Holding the card firmly on the glass, quickly turn the glass over. Remove your hand from the card carefully.
   CAUTION: Perform this experiment over a pail or similar container.
3. Submerge a tumbler and allow it to fill with water. Turn it to an inverted position and lift it straight up until nearly all of the glass is above the water. Tell why H_2O would not run out of the tumbler.
4. Obtain two plumber's force cups and wet the bottom rim of each cup. (Two suction cups of equal size may be used instead.) Press the cups together to expel the air inside the cups. When you try to pull them apart, you may find this to be very difficult. Why?
5. Make a nail hole near the bottom of a small sized tin can. Fill the can with H_2O, hold the palm of the hand tightly over the top of the can, and the water will stop flowing from the hole. Lift the hand and the water will start to flow again. What can account for the stoppage of water?



6. Place a drinking straw in a full bottle of water. Press clay around the neck or close the opening between the straw and the bottle. Hold the clay tightly to the bottle with your fingers and try to drink through the straw.
7. Insert a glass tube into a one-hole stopper. Insert the stopper into a soda pop bottle completely filled with water. Suck on the tube and try to get a drink of water. Loosen the stopper and try again.
8. Show that air pressure on a parachute slows the fall of an object. Make a parachute from a piece of cloth. Drop an article without parachute attached, then with parachute attached.
9. Make model rockets from clay.
10. Grow plants with and without light.
11. Throw ball into air; discuss why it always comes down.
12. Shine flashlight on turning ball to demonstrate night and day.
13. Make parachutes of large handkerchief. Tie object to it. Observe how air slows the fall of object.
14. Make kites and fly them.
15. Keep daily weather chart with comments about "good" flying weather.
16. Fasten inflated balloon to small lightweight toy so that when air is released toy will move forward.
17. The "pop bottle" barometer shown in the diagram will indicate changes in pressure only if it is kept at uniform temperature. If the temperature is allowed to vary, it will operate on the same principle as a thermometer. Discuss the reasons for this.
18. Make a simple anemometer like the one shown in the diagram. Note the behavior of the vanes when the device is held in the wind or in front of an electric fan. Point out that commercial anemometers have a registering device that works like a speedometer on an automobile.





AIM: While continuing the interest in *Man in Space* — being alert to any new developments in the space program, a study of the Nature of the Universe, would be appropriate, beginning with the solar system, then going into the study of related subjects such as geology, weather, biology and botany.

Concepts To Be Developed	Activities	Resources
There are nine planets rotating around the Sun. This is called the Solar System The planets in order are: Mercury Venus Earth Mars Jupiter Saturn Uranus Neptune Pluto	Learn the names and order of the planets, using a nonsense quotation to help: "Many Vicious Elephants Move Jungles Searching Unfriendly Native Parties"	Room Environment: 1. Pictures of the planets showing their order 2. A globe of the Earth 3. A model of the Sun with the Earth rotating around it.
The earliest man was interested in the heavens above. The first tool for observing the stars and planets was a pair of eyes	*Science:* Begin keeping a Moon chart, showing the changes of the Moon[1]	
	Language: Dictionary work— Begin building a working vocabulary on the Solar System. The following words should be defined and added to each child's Space notebook: astronomy comet galaxy gravity light-year lunar orbit meteor meteorite solar universe	

[1] Elementary Science Study, Unit: "Where is the Moon."
Grades 3-7 — Webster Division, McGraw-Hill Book Company, 411 Elm, Dallas, Texas 75202.

Concepts To Be Developed	Activities	Resources
The Earth is a ball nearly 8,000 miles across.	*Math:* Work on comparisons in distance and size, practice reading large numbers and discuss scaled measurement.	
The Sun is 109 times greater than the Earth.	*Science:* Count out 109 BB's. Draw a straight line across a large sheet of paper. Spread glue on the line. Make sure the BB's touch one another. Draw a large circle around it. Imagine the circle to be the Sun, the BB's to be planets the size of the Earth.	
The planets vary in size. Jupiter is the largest. Pluto, the smallest.	(see table below)	

Planet	*Diameter*	*Scale Measurement*
Mercury	3,000	1 inch
Venus	7,600	2 1/2 inches
Earth	7,900	2 3/4 inches
Mars	4,200	1 1/2 inches
Jupiter	87,000	2 feet & 5 inches
Saturn	71,500	2 feet
Uranus	29,500	10 inches
Neptune	27,000	9 inches
Pluto	3,600	1 1/4 inches

Using the scale measurement on page 7 cut pictures of each planet to show comparison in size.

Concepts To Be Developed	Activities	Resources
	Art: Sunset Scenes — Cut and paste windmills, birds, planes, etc. from black construction paper. A silhouette effect is achieved by pasting the pictures on white paper, 8" by 12". Blend in sunset colors using colored chalk.	Film: ***What Makes Night and Day?*** Elementary Science Series, Young American Films, McGraw-Hill, Inc.

Concepts To Be Developed	Activities	Resources
Everything we do takes up space Heat energy from the sun travels through millions of miles of space to get here to warm the Earth. Early man identified outlines of imaginary figures in the sky formed by groups of stars called constellations. The Greeks began charting the stars		Film: *What Is Space?* Prod — EBF Dist — EBEC Encyclopaedia Britannica Films
Early man made guesses about the Universe and was sometimes wrong.	Discuss, on a simple level, the work of Aristotle—how people accepted and believed his ideas regarding an Earth-centered-Universe.	Film: *How Do We Know The Earth's Shape?* Film: *How Do We Know The Earth Moves?* Film: *How Many Stars?* Prod—MIS Dist—MIS Moody Institute of Science Educational Film Division 17000 E. Washington Blvd. Whittier, California 90606
Most of the planets are named for Greek and Roman nythological characters	Read aloud each day for a determined length of time. Make picture dictionaries for a *Language* assignment. Show the following gods and goddesses: Athens—wisdom Apollo—sun Diana—moon Neptune—sea Mercury—messenger Venus—love Mars—war Jupiter—king of all the gods	*Stories of Gods and Heroes* adapted by Morris Schreiber
Three gods rode in chariots: Apollo's chariot was pulled by horses, Diana's by hounds, and Neptune's drawn by seahorses. The Olympic Games were begun in ancient Greek times.	*Art:* Make cut-outs of these three mythological characters. Paste black construction paper *Language:* Read to the class about the history of the Olympics	
	P.E. Work at some track events —50 yard dash, 600 yard walk-run, standing broad jump *Math:* Mark field, using measurement Practice using stop watch	*The First Book of the Olympic Games* By John Walsh Film: *Track and Field*—Narrated by Bob Mathias Prod—UWF Dist—UEVA United World Films

Concepts To Be Developed	Activities	Resources
	Health:	
When an athlete is in training, he eats well and gets plenty of rest and exercise. He doesn't smoke.	The nurse might come in to discuss with class a gord health prog.am The children are tested in the "step-up-step-down" test to see if they can qualify for the physical fitness training and testing required by the state	
	Geography:	
Columbus helped to clear up a misconception of long standing. That the Earth was flat	Review the continents and discuss the discovery of North and South America	
	Discussion	
Copernicus followed Columbus and set forth the idea of a sun centered universe. His ideas were ridiculed		
Galileo was an Italian who accepted Copernicus' ideas about the universe Unlike Aristotle, Galileo accepted as true only what he could prove	Read aloud and discuss the life of Galileo *Science:* Read about and discuss Galileo's laws of falling objects Take turns dropping a light and a heavy object simultaneously to determine whether one would fall to the ground first.	*Galileo* Author: Gregor A. S. Scribner, 1961. Grades 2-7
	Social Studies:	
A heavy object and a light object, when dropped at the same time, fall to earth simultaneously. B.C. means Before Christ A.D. means Anno Domimi, in the year of our Lord	Make a timeline to be placed on the bulletin board. Have the children draw pictures and place them at the proper date. Begin with John Glenn's flight and work backwards, adding to it during the year	
Galileo developed the telescope, which paved the way to more accurate study of the universe	Discuss the difference between Galileo's telescope and the telescope at Mount Palomar.	

AEROSPACE ART

Draw or paint pictures of a space pilot.

Draw or paint pictures of a moon station.

Draw or paint pictures of the "man on the moon" or other figures imagined on the moon.

Draw or paint pictures of a trip to the moon.

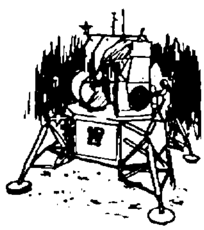
Make a glider or airplane out of paper.

Build an airplane out of blocks.

Build an airport with blocks.

Draw or paint different kinds of clouds.

Draw or paint pictures of different kinds of airplanes, then make them into a mural.



Build a space capsule with blocks.

Draw or paint pictures of planets.

Draw a picture of a moon station.

Draw or paint pictures of space adventures.

Draw or paint pictures of rockets.

Make a rocket of cardboard tubes. Make an oatmeal-box capsule for a monkey, using clay and cotton to fit and pad it.

Make clay monkey to fit into the capsule.

Draw or paint pictures of the moon in phases.

Draw or paint pictures of the moon. Show the surface in the detail.

Make a picture book of different kinds of airplanes.

Make silhouettes of common kinds of airplanes. Use them as flashcards.

Have an exhibit of model airplanes.

From sturdy boxes, make an airplane large enough for the children to get into.

Construct a table-model airport.

Draw or paint pictures illustrating the history of ballooning.

Draw or paint pictures of satellites.

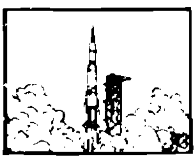
Draw or paint pictures of space travel or of what might be seen in space.

Build a table-model rocket base.

Draw or paint moonscapes.

Make imaginary moonscapes using clay.

Make gravity pictures with string dipped in tempera paint. Place the paper on the floor and allow the string to fall where the gravity will cause it to fall.

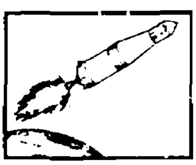


Make a paper-bag space helmet.

Make oatmeal-box oxygen tanks.

Build a table model of a space station.

Construct a large table-model Mercury capsule using chicken wire for framework. Cover it with aluminum foil. If possible make it large enough for a child to get into.



Make a mural of our galaxy in space, showing approximate location of our solar system.

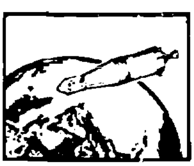
Draw or paint pictures of space vehicles.

Construct dioramas of an airport.

Make balloon models and use as mobiles.

Draw landscapes of the major planets.

Make paper models of satellites. Hang them as mobiles.



Build a table model of Cape Kennedy.

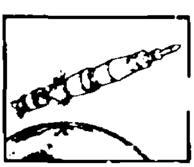
Make imaginary "moonscapes" with clay.

Make a three-dimensional map of the moon.

Make papier-mache models of the planets.

Build a model Nike base.

Make a table-model lunar vehicle.



Make clay models of different kinds of rockets, missiles and satellites.

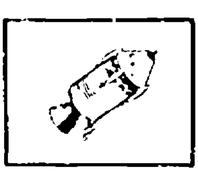
Make diagrams of rocket and jet motors.

Make a three-dimensional map of the moon.

Prepare a mural of the history of flight.

Make models of historical airplanes.

Dress a doll in a model space suit.



Aerospace Activities
Secondary Level

HOME ECONOMICS IN AEROSPACE

When man ventures into the hostile environment of space, he must take with him all the things he needs to keep him alive and comfortable: food, clothing, shelter, even the air he breathes and the water he drinks. For protection during space flight, the astronaut must have a spacecraft especially designed to shelter him from the hazards of space. He also requires a spacesuit which can be pressurized to protect him during extravehicular activity or in such cases of spacecraft pressure failure. For body energy, he must have food that is highly nutritious and especially prepared to be handled and eaten during the conditions encountered in space flight.

There are several aspects of space that make sustaining life a more complex process than it is on the surface of Earth. The factors to be considered are vacuum or total absence of air, a lack of atmospheric pressure, a lack of oxygen, weightlessness or zero gravity, ionizing radiation from solar flares which can be more deadly than the radiation of a nuclear bomb, and micrometeoroids that could penetrate the surface of the spacecraft. In addition, there are extremes of heat and cold much greater than those encountered on earth. Temperatures on the surface of the moon vary from a minus 243 degrees F. in the dark areas to plus 212 degrees F. in direct sunlight. This is the type of environment in which man must live and work as part of space exploration.

The environment to which man is normally accustomed is that of earth's gravity and atmospheric pressure. To survive extremes outside of these conditions, an adequate environment must be provided. The spacesuit can provide a suitable environment in addition to that provided by the environmental control system of the spacecraft.

The spacesuit designed for the crews of NASA'S spacecraft, consists of four layers which fit loosely inside one another. The layers are fastened together only around the boots, the zipper, the connections for the oxygen hoses and the medical instrument wires. The garment, complete with helmet and boots, weighs approximately 30 pounds.

The outside layer is made of a high temperature resistant white nylon. Beneath the outer layer is the restraint garment, so called because when the suit is inflated, it keeps the suit from billowing. It is woven of nylon net fabric and designed to allow mobility when inflated. The third layer is treated with rubber to make it almost airtight. The innermost layer is a smooth soft nylon layer designed for comfort.

The spacesuit is designed to provide safe protection against vacuum, heat, and cold. This suit is primarily an intravehicular suit and affords little if any micrometeorid protection. The spacesuit is designed as a backup to function in the event of pressure failure.

Air inlet and outlet connections are located on the torso of the suit at waist level. A near 100 percent breathable oxygen system is provided to the suit from storage bottles.

Two pockets, one located between each knee and ankle, hold tools for opening food packages during flight and for cutting parachute lines if necessary on landing. Two large shin pockets are provided for flight plan data storage.

Accessories — Gloves are attached to the suit at the wrist with quick disconnect couplings. A small battery pack and two fingertip lights are mounted on each glove. This provides a small light source the astronaut needs when reading spacecraft instruments while on the dark side of the Earth.

The helmet has a built-in drinking port through which the astronaut can insert the nozzle of a "water gun" into his mouth without removing the helmet. The helmet provides visibility, comfort, and windblast protection. The communication system consisting of ear phones and microphones is an integral part of the helmet. Disconnect couplings also attach the helmet to the suit to facilitate removal or donning.

Three Suits for Each Astronaut—Primary crews are provided with three suits. All suits, including the boots, gloves, and helmets, are individually tailored. One suit is for training, a second for the actual mission, and the third is provided as a backup.

Since the water supply on a spacecraft is limited, the manner of shaving, brushing teeth, and bathing must be changed.

A shaver operated by a spring motor, like a windup toy train is used. It has a built-in vacuum cleaner that collects the cut whiskers—which otherwise might float around getting into eyes and noses or fouling instruments because of the weightlessness and zero-gravity atmosphere.

For teeth brushing, they may either use a chewing gum something like one which now advertises its tooth cleaning as well as pleasant taste or a toothpaste which is treated so that it is edible The astronaut eats the used dentifrice instead of spitting it out.

For "washing up," they'll use a chemically impregnated near-lintless cleaning tissue, to prevent water droplets and lint from fouling the instruments.

Regarding physical activity and sleep, the astronauts have no room to stand up straight or lie out flat for rest. The spacecraft limits their movement because of a need to conserve space. Exercise routines are done by isometrics.

HOME ECONOMICS

OBJECTIVES

1. The student will describe how mans' environmental needs are met in space flight in terms of seven atmospheric conditions (such as: weightlessness, lack of oxygen, etc.): on type of clothing; three personal hygiene and fitness habits (such as: shaving, brushing teeth, and bathing); two sanita-

tion procedures; and three problems encountered in providing an adequate diet (such as weight load on the spacecraft, the weightless condition of space, and low residue for waste disposal).

2. The student will be able to list eight physical changes (such as: cardiovascular, muscular, and skeletal changes due to weightlessness, negative calcium balance, dehydration, negative nitrogen balance, etc.) which could take place in the human body due to living in a spacecraft.

3. The student will explain the main use of a low-residue diet as it relates to waste disposal on a spacecraft; the lowered caloric requirements as affected by physical activity on a space craft; and adequate levels of carbohydrates, fats, protein, vitamins, minerals and water as a necessity for optimum astronaut nutrition.

4. Given a list of foods, the student will plan a nutritious meal by selecting only those which are low-residue foods.

5. The student will prepare a low-residue meal and evaluate texture, flavor, appearance, juiciness, and acceptance on a nominal scale.

6. The student will describe in detail the one main method of dispensing water on a spacecraft for drinking and food reconstitution.

7. The student will be able to name and describe in general the types of diets under investigation for long duration flights and their feasibility.

8. The student will list eight current techniques of food processing used in the food industry and one example of a food characterized by each technique.

9. The student will name and describe in general how food for the future may be obtained from oceans and lakes and from organic and inorganic substances.

ENERGY REQUIREMENTS FOR VARIOUS ACTIVITIES DURING SPACE FLIGHT

		Energy Expenditure	
Activity	Time (hour)	Rate Cal./Min.	Total Performance Calories
Sleep	7	1.2	504
Quiet sitting or standing	12	1.5	1080
Instrumentation	2	1.8	216
Complex neuromuscular tasks	2	2.6	312
Moderate work	1	7.0	420
			2532

The diet contains about 150 grams of fat, 310 grams of carbohydrate, and 80 grams of protein for a total of 2800 calories. The urine volume on this diet would be about 800 milliliters per day. The fecal losses are minimized by the use of low-residue foods. The diet contains about five per cent crude fiber and results in an average daily output of 30 to 85 grams of feces. Three liters of water per day are included with this diet. Since astronauts are busy and preoccupied, water intake must be programmed into the daily schedule. Salts to provide levels about 10 per cent above earth allowances are added to provide calcium, magnesium, potassium, and sodium. Liberal allowances of ascorbic acid and Vitamin E are included. Other vitamins are provided on the basis of the recommended allowances.

NUTRITIONAL NEEDS ON LONG DURATION FLIGHTS

Environmental conditions in space such as weightlessness, heat and cold, wearing of pressurized suits, inactivity, and cabin temperature may produce more definite changes in nutrient requirements on long duration flights.

On long-term space travel, the effect of prolonged inactivity could cause a negative nitrogen balance. Also, a prolonged constant cabin temperature could lower the basal metabolic rate thus lowering the energy requirements of man.

The sweating process plays an important part in determining energy requirements of men exposed to solar radiation or high temperatures. Considerable nitrogen is lost in sweat. An increase in protein is necessary under conditions that produce a great deal of sweating.

Another change in nutritional needs may be due to the continuous wearing of pressurized suits for extended flight explorations. A diet of precooked freeze-dried foods seems efficient in supplying the necessary nutrient requirements. During periods of inactivity, while wearing the pressure suit, there is no need to increase the nutritional requirements. However, during periods of exercise, both water and energy requirements need to be increased.

The water requirements for long duration space flights are very important. Both caloric requirements and water requirements are strongly affected by physical activity, thermal environment and clothing. As a minimum, two liters of fluid should be provided daily with provision for additional water, if necessary. Of this amount, one to one and one-half liters become urine and one liter becomes water vapor, leaving the lung surfaces and the skin as "insensible" perspiration. If any visible perspiration occurs, the water requirement may rise to many times the basic value. Even if there is no visible perspiration, as in the hot, dry desert, water needs rise sharply with the temperature. Some water is made from food that is eaten. In the metabolism of carbohydrates such as sugar, about one gram of water is formed for every gram of food.

The dietary recommendation of long duration space flights is that the diet be as simple as possible with the maximum use of natural foods. The diet preferred is a liquid formula or one which can be reconstituted to liquid or semi-liquid form. The caloric requirements for a 150 pound man should provide 2700 to 3200 calories per day of which 12.5 per cent are protein, 52.5 to 57.5 per cent carbohydrate, and 30 to 35 per cent fat.

Evolving from this new interest in nutritional needs for space travel has been a new technology entitled Gastronautics. Gastronautics is "a new interdisciplinary technology—astrophysiological dietetics—regulation of diet consistent with the normal functioning of an organism beyond the earth environment."

Packaging of Foods for Flight — Early space feeding was mainly that of serving liquids and semi-solid foods from collapsible squeeze tubes. These tubes were like aluminum toothpaste-type tubes with a nontoxic food grade organic inside coating. These special coating materials were applied to the inner surface of the aluminum tubes to prevent formation of hydrogen gas, which would have resulted from reaction between the metal and the acids in certain foods, such as applesauce. Precision filling and sealing techniques were devised to eliminate any trapped gasses which might expand and rupture the container when the pressure in the spacecraft cabin was reduced. A new gasketing material was developed to increase protection against leakage or spoilage during storage. Special in-the-tube sterilization techniques were also employed to preserve the contents. The average tube of food weighed 5½ ounces, with the aluminum tube accounting for a large proportion of this weight. The weight of the tube in proportion to the weight of the food was considered to be too high, but subsequent development of a lightweight plastic container helped to overcome this problem.

The food in these tubes is transmitted to the mouth of the astronaut by applying pressure to the tube. The food is fed into the mouth through a three and one-half inch polystyrene pontube which screws onto the aluminum tube and cuts open the tube when it is attached. During space flights, when the space suit may not be pressurized, the face plate can be opened to allow the food to be squeezed directly from the tube into the mouth. But if the space suit is pressurized, the pontube must be used and it is inserted into an opening in the face plate of the suit.

For foods which need reconstitution with water, a package was designed with an enclosed aesceptic tube which extends to submit water and through which the food was directly fed into the mouth. This packaging was transparent to enable the astronauts to identify the foods. This laminate was developed to provide adequate heat sealability, very low water vapor permeability to protect foods against moisture pick-up and oxidation, and durable enough to meet the stresses of reconstitution of foods.

The sandwiches, bacon and fruit cake packages were provided with a pull-tab arrangement for dispensing the food. The dispenser for bite-size pieces was made of Plexiglas and contained a pull-tab and a closure flap of polyethylene. The astronauts removed the bite-size pieces by hand and placed them directly in the mouth while the face plate was open. In the early flights, a water-proof polyethylene mitten was worn over the pressure suit gloves for sanitation purposes.

FOOD CONCEPTS FOR LONG DURATION FLIGHTS

Long duration space flights have been considered to be of three months duration or longer. Weight, storage, waste disposal, and water supply will be of prime concern on these flights. In order to minimize storage and weight, several types of diets have been proposed.

Investigated Diets

Taking an energy pill instead of eating a meal is more like science fiction. Mealtime is an important part of the day for the astronauts in order to avoid monotony. The energy pill concept, not highly favored, would require 90 large size capsules for the protein, minerals, and vitamins and 250 capsules in the form of fat to provide 2200 to 2500 calories per day. The psychological and physiological aspects of consuming such a large number of pills per day almost rules out this concept.

Another proposal is to increase the body weight of the space traveler before flight and he will then utilize this increased fat during space flight. This would be similar to a semi-starvation diet. The psychological aspects of this semi-starvation diet make it nonacceptable.

A third diet concept is the use of liquid formula diets containing chemicals for a well balanced diet. The levels of all nutrients must be adequate if it is to be used as the only food source. This diet provides 20 to 40 calories per fluid ounce. The advantages of this diet are that it would shorten food preparation time and provide sterile food.

Synthetic diets for space programs have also been studied. The chemical diet consists of proportions of L-amino acids, the required water-soluble and fat-soluble vitamins, pertinent salts, glucose and ethyl linoleate as the source of essential fat. Only distilled water may be added to the diet. Studies on this diet have demonstrated that there were no adverse physiological or psychological effects. The physical status and psychological outlook after consumption of the diet was good. Fecal residue was strikingly reduced. The major advantage of this diet is that one cubic foot of the diet will provide a 154 pound astronaut with all the required nutrients and 2830 calories per day for one month. In addition, this synthetic diet is completely water soluble, low in bulk, completely digestible, and has good storage stability.

Each day, an average man requires, in addition to about 2 lb. of oxygen, almost 7 lb. of water, and approximately 2 lb. of food. This is his intake. His output consists of about 2½ lb. of carbon dioxide, almost 8 lb. water, and just a small amount of solids, urea, and minerals. Thus, he consumes the equivalent of his weight in about 15 days. In only 6 months, he takes in about a ton of oxygen, food, and water. On extended missions, it will be prohibitive to carry along all these supplies, and it will be necessary to use some of man's output for developing an input.

Current Innovations with Nutrients

Some unique ideas and innovations with the use of nutrients are being investigated for space flight. Clothing could be made of fibers spun from soy bean, casein, and zien. The United States Department of Agriculture has already developed fibers from egg whites and chicken feathers.

There is a possibility of using edible structures for the design of spacecraft fuel tanks, rocket motors, and lunar rocket launch facilities. Other ideas include the use of transparent sugar castings as a substitute for optical

glass; glue and adhesives from fish, animal protein or starch; paper from soybeans, egg albumin or starch; and ink from vegetables.

The astronaut of the future who undertakes a space journey lasting from two to four years may receive a complete meal by chewing a concentrate the size of a licorice stick. The meal stick which is being developed will contain all the necessary vitamins, minerals, and calories of a full meal.

Investigation has gone into the synthetic development of high energy metabolites which are compounds having a greater density of calories for a given weight than the usual source of calories. These have been studied to lessen the weight and volume of food. Two compounds that have a caloric content higher than carbohydrate are being tested for consumption by man. These compounds are 2.4 di-methyl hepatanoic acid (2,4-DMHA for short) and 2-3 butanediol and do not exist in nature. They were designed entirely from consideration of biochemical and physiological energy requirements. It has not been advocated that the next astronauts carry a liquid diet of 2,4-DMHA and 1,3-butanediol, even though all kinds of tempting flavors could be added. A great deal more study is needed before it can be fed to humans. This is the first time a nutritional source has been designed that is potentially more efficient than nature. Always before the attempt has been to imitate nature. Because future space travelers will probably live on nutrients recycled from their own body wastes, this type of food may serve as "lifeboat rations." When the space traveler leaves his ship, these nutrients may be just what he needs.

The chemical synthesis of proteinoids from amino acids to go along with the synthetic vitamins is another possible food source. This chemical synthesis must be inexpensive and simple to operate for long duration space flights. These proteinoids have an acceptable taste similar to grilled fish in either the raw or roasted state.

Water that can't leak has been investigated. It's stored like jelly. It turns liquid only when squeezed, and becomes like jelly again when the pressure is relaxed. A substance somewhat like the gelatins used in ice cream which is edible could be put in an astronaut's drinking water or his soup. Since in space there is no gravity, water tends to ball up—form in droplets and this makes it hard for an astronaut to transfer it from one container into another containing dried, powdered food. There is a tendency for the droplets to escape and drift around in the cabin. Subsequently, this new gelled water does not break up into droplets. If some should escape, it becomes a gelatinous mass and simple to recover. It's not likely to float around and short cut the circuitry. When a glass of this water is turned upside down the liquid remains in the open glass. It can be spooned out, or transferred to a plastic squeeze bottle and can even be served cold.

There has been investigation into the development of a building material made from edible contents. This material contains hominy grits, powdered milk, cornstarch, flour, and powdered banana flakes. It is harder than fiberboard and contains 300 to 400 calories per 100 grams. For emergency food, it can be ground or soaked for 24 hours to make a cereal having a banana flavor. When molded in sheets and coated with a removable film laminate this

edible material can be utilized for structures in space stations such as instrument panels, bunks, clipboards, walls, packaging and compartment dividers.

Many of these new nutrient ideas need much research before they can actually be utilized for space flight.

SUGGESTED ACTIVITIES

1. The student might collect pictures of astronauts' spacesuits and discuss the reason for the types of construction and the fabrics used, as relates to space flight.
2. The students could be divided into groups. Each group plans a meal and presents to the class, through demonstration, what would happen to each type of food if eaten under the conditions which exist in space.
3. The student could develop a written list of physical changes which might take place in the human body due to living in a spacecraft. Class discussion could evolve from these lists.
4. The students could plan two nutritional daily menus. One menu planned for a very active man and requiring a high caloric level. The second menu planned for a little-active astronaut and requiring a low caloric level. A comparison of the two menus could stimulate a discussion on caloric requirements.
5. Utilizing the daily menu planned for the astronaut which contains a low caloric level, the students might evaluate the menu to determine if they had provided adequate proportions of carbohydrates, protein, and fat.
6. From a list of astronaut foods, the students could plan three meals. One meal for a Mercury flight, one for a Gemini flight, and one for an Apollo flight. The three meals might then be evaluated for adequate proportions for the necessary nutrients.
7. Menus for Gemini and Apollo flights could be shown to the students. The students might evaluate the menus to determine whether each food would or would not be acceptable for space flight.
8. A discussion might be stimulated on the reasons for establishing strict weight, volume, packaging, and nutritional requirements for space food.
9. To stimulate discussion of the eating of space foods on a spacecraft, the teacher might puree some food in a blender and seal the pureed food in small plastic bags. The students might clip the corner of the plastic bag and squeeze the food into the mouth as the astronauts would do on flight.
10. A discussion might be developed on how the production of space food has influenced the production of certain consumer foods.
11. The teacher might have the students develop a list containing possible means of obtaining foods for the future, in the event the world food supply would run short. A discussion on foods of the future might evolve from these lists.

VOCABULARY LIST

1. orbit
2. satellite
3. vacuum
4. meteroids
5. probe
6. planet
7. eleptic
8. crater
9. sound barrier
10. payload
11. solar cell
12. fuel cell
13. freez-dehydrated
14. telescope
15. radar
16. telemetry
17. lift-off
18. potable
19. pressure suit
20. posigrade
21. retrograde
22. lunar rover
23. mare
24. solar wind
25. ultra violet
26. ionosphere
27. atmosphere
28. rocket burn
29. orbital period
30. second stage
31. retro rocket
32. heat shield
33. ablation
34. rendezvous
35. docking
36. module
37. spacecraft
38. launch vehicle
39. supersonic
40. hypersonic
41. touchdown
42. computer
43. lunar
44. meteorite
45. atomic power
46. sublimation
47. eclipse
48. aeronautics
49. sonic boom
50. countdown

THE SOCIAL STUDIES AND AEROSPACE

THE SOCIAL IMPACT OF AVIATION UPON SOCIETY

I. Aims and Objectives

This unit is designed to help students:

1. Understand the national and international problems created by aviation.
2. Become aware of the part played by research in aerospace development.
3. Appreciate the services and responsibilities of all phases of domestic, international, and military flying.
4. Realize the growing interdependence of all people through aerospace development and related fields.
5. Appreciate the changes brought about in geographic relationships by the elimination of national boundaries and the changing concepts of time and space.
6. To comprehend more fully the magnitude of occupational opportunities offered by the aviation industry.

II. Outline of Unit Content

This unit is designed to help the student:

1. Understand the national and international problems created by aviation through the study of:
   a. Customs and conditions
   b. Language barriers
   c. Climatic conditions
   d. Geographical relationships
2. Understand the social impact upon the community where research centers are located.
3. Appreciate the services of all phases of air transportation by studying:
   a. Military uses of the airplane
   b. Public uses of the airplane
4. Study the mobility of our society and the psychological and sociological effects of it due to the changing concepts of space and time.
5. Understand the growing interdependence of all peoples through aerospace development and related fields.
   a. Personnel
   b. Education and training
   c. Accounting and finance
   d. Supply management
   e. Data management and processing
   f. Weather
   g. Behavioral science
   h. Maintenance and engineering
   i. Aircraft control
   j. Aerospace medicine and foods

6. Study the magnitude of occupational opportunities offered by the aviation industry.

III. *Suggested Student Activities*

1. Make a bulletin board showing job opportunities in aviation.
2. Field trips to a local airport to see what various occupations are employed there.
3. Write to foreign embassies and obtain weather information and terrestrial conditions.
4. Make a map showing locations of various materials used in the construction of aircraft and spacecraft.
5. Make a map showing locations of research centers.
6. Engage the pupils in a Pen Pal Club with students from foreign countries.
7. Keep a notebook on the social, psychological, and physical changes and influences effected upon our society due to the "Space Age."

SOCIAL STUDIES AEROSPACE CURRICULUM DEVELOPMENT

The goal of aerospace education is not to make every student a professional pilot. The primary objective is to help all students understand the economic, social, cultural, and technological implications involved in aerospace—its operation, its problems, and most of all its possibilities. Because aerospace is such a dynamic and growing field, new problems and new areas are constantly arising, making it necessary to make changes. Because it is not static, what may be an adequate answer to any given problem today may not be an adequate answer tomorrow. One of the most important aspects of a student's education, therefore, should be to learn that while the techniques of problem solving may remain the same, no solution can be considered final. This conclusion has been dramatically demonstrated in the Mercury to Apollo missions in reaching the moon.

A study of the impact of aerospace is beneficial whether or not the student continues with any phase of aerospace or ever gets a pilot's license. All students who take a course in chemistry will not become chemists just as all students learning about aerospace will not become astronauts.

Aerospace education has unlimited possibilities and responsibilities to be a part of the fabulous future of the field of flight.

Government Involvement In Aviation

I. **Aims and Objectives**

The specific aim or objective of this unit is to help the student realize that our air space is our greatest national/natural resource, and as such necessitates government involvement and supervision.

II. **Outline of Unit Content**

This unit is designed to help the student:

1. Understand why our government is involved in aviation and aerospace.
   a. Military development and security
   b. Space exploration

c. Airport development
d. Airway systems development

2. Understand how our government is involved in aviation and aerospace.
   a. Laws concerning Air and Space
   b. International regulations
   c. Federal regulation of aviation
   d. Economic regulations and aviation
   e. State regulation of aviation
   f. Local regulation of aviation

III. Suggested Pupil Activities

1. Make a pie chart showing % of Military aircraft, General Aviation aircraft, and Commercial aircraft.
2. Prepare a bulletin board illustrating the advances in Military aircraft.
3. Spacemobile visit illustrating aspects of the space program.
4. Invite guest speakers to speak on such subjects as:
   a. Airport management
   b. Air control
   c. Registration of aircraft and pilots
5. Field trips to FAA Academy in Oklahoma City (if location will permit).
6. Trace the development of Federal regulation from the Federal Air Mail Act of 1925 to the present.
7. Study how the FAA investigates aircraft accidents.

AEROSPACE TERMS

Aerodynamics
The science that treats of the motion of air and other gaseous fluids, and of the forces acting on bodies when the bodies move through such fluids, or when such fluids move against or around the bodies.

Air density
The ratio of the mass of air to its volume, expressed as its weight per unit of volume, e.g., 1 kilogram per cubic meter.

Airfoil
A surface which furnishes lift, thrust or control to the vehicle.

Airspeed
The speed of an aircraft in relation to the air through which it is passing.

Airway
An air route along which aids to air navigation, such as beacon lights, radio ranges and direction finding facilities, and landing fields are maintained.

Altimeter
An instrument for indicating the relative altitude of an airplane by measuring atmospheric pressure.

Animometer

A device for measuring the velocity of the wind, in common use at airports.

Apogee

The point in an elliptical orbit around earth which is farthest from earth.

Apollo

United States program with the objective of earth-orbiting a space laboratory, launching astronauts to the vicinity of the moon, and landing a man on the moon, and returning him to earth.

Astro

A prefix meaning "star" or "stars" and, by extension sometimes used as the equivalent of "celestial," as in astronautics.

Azimuth

The initial angle or direction between true North and a great circle course.

Bernoulli's Principle

As the speed of a confined fluid increases, the fluid pressure decreases.

Bioastronautics

Astronautics considered for its effect upon animal or plant life.

Center of Gravity

The point through which the resultant forces of gravity acts no matter how the body is oriented.

Centrifuge

A large motor-driven apparatus with a long rotating arm at the end of which human and animal subjects or equipment can be revolved at various speeds to simulate very closely the prolonged accelerations encountered in high-performance aircraft, rockets, or manned missiles.

GENERAL SCIENCE AND EARTH SCIENCE IN AEROSPACE

Unit: Aviation

Topics: History of Manned Flight
- sample reference—FAA films

History of Aircraft Development
- sample reference—Smithsonian Institute booklets

Aircraft Construction
- sample reference—Piper Aircraft booklets

Forces Acting on Aircraft in Flight
- sample reference—Jeppesen and Company

Function of Aircraft Controls
- sample reference—Sanderson Company

Flight Maneuvers
- sample reference—FAA films

Atmospheric Characteristics
- sample reference—FAA, Weather Bureau

Weather Map Interpretation
- sample reference—FAA, Weather Bureau

Radio Communications
- sample reference—CAP, FAA

Air Traffic Rules
sample reference—FAA
Aerial Navigation
sample references—FAA, CAP, Sanderson Company

Suggested Activities:

1. Have students bring a collection of aviation magazines.
2. Have students bring newspaper clippings concerning aviation to place on the bulletin board for the aviation unit study.
3. Invite a local airport operator to speak to the class about aviation of the area.
4. Visit the local airport, with assistance of the local airport operator.
5. Visit a nearby FAA Flight Service Station.
6. Have students bring model airplanes for a hanging display during th unit of study.
7. Invite a representative of a model airplane flying club to speak an perhaps give a flying demonstration for the class.
8. Have an in-class contest of paper airplane, kites, glider, rubberband powered planes and gasoline powered planes.

GENERAL SCIENCE AND EARTH SCIENCE

Unit: Space Flight
Topics: History of Rocketry
sample reference—NASA films
Rockets and Newton's Laws
sample reference: Holt Company,—Library of Science
What is a Satellite
sample reference—NASA Films *Publication.
Kinds of Satellites
sample reference—NASA Films
The Universe
sample reference—Film "Universe"—NASA
Manned Space Flights
sample reference—NASA Film
Taking Earth's Environment Into Space
sample reference—NASA Films
Space Flights to Other Planets
sample reference—NASA Films

Suggested Activities:

1. As a class project have the students build a mobile of the solar syst m
2. As a class project have the students build paper models of spacecraf:
3. Have the class simulate 1/6 gravity of the moon by suspending 5/6 the weight by a rope to an overhead support.
4. Have the class build model rockets.
5. Have a model rocket contest by judging both the appearance and a tude of the rocket when it is fired.
6. Have the students build a mock-up space suit.

7. Have a contest of the student's drawings and models of a proposed vehicle to travel on the moon.
8. Have the class build a model of a space station large enough to house 50 people and show where all the various types of equipment would be located.

AEROSPACE EDUCATION IN THE LIFE SCIENCES

Suggested areas of approach:

I. Environmental Biology

A. Biosphere—general discussion of the film of life
B. Exosphere—general discussion of the film of life
C. Life support systems to be considered in both biosphere and exosphere.
   1. Oxygen content control
   2. Pressure—both normal air pressure and artificial pressure
   3. Thermal control
   4. Water
   5. Food
   6. Waste control
   7. Hygiene
   8. Radiation effects
   9. Protection—radiation, meteorites, etc.
   10. Contamination
D. Implementing support systems in exosphere

II. Physiological Aspects of Aerospace

A. Physical effects: such as
   1. Circulation
   2. Respiration
   3. Pressure
   4. Weightlessness and muscle-tone relationships
   5. Dehydration
   6. Fatigue
   7. Various physical conditions such as hypoxia, hyperventilation, flicker vertigo, coreolis effect, etc.
   8. Visual orientation
   9. Cosmic radiation
   10. Possible meteoroid bombardment
B. Psychological Effects
   1. Requirements and training
   2. Stress
   3. Phobias
   4. Long periods of isolation
   5. Induced hiberation studies
C. Aeromedicine
   1. Experimentation—past and present
   2. Medical technological advances
      a. Cardiovascular monitoring devices

b. Electrostatic cameras for monitoring patients
c. Heart valve improvement
d. Transducer transmitter that relays intestinal data
e. Laser surgery
f. Aids to blind and deaf
g. Walking wheel chair
h. Other bionic devices

D. Health Education
1. Safety
2. Fitness
3. Personal hygiene

E. Effects of biological clocks (interruption of normal cycles)
1. Man
2. Animals
3. Plants

III. Genetic Effects — Mutations
A. Radiation
B. Weightlessness

Suggested Laboratory Exercise:

Procedure:

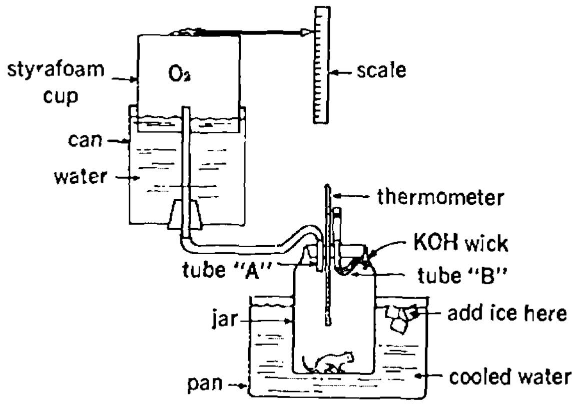
Select two containers, one of which will easily fit into the other. Affix pointer to the top of the smaller container. Use glue to fasten the stick. Drill a hole in the center of the bottom of the larger container. The diameter of the hole should allow the one-hole stopper to just enter. Adjust the height of the tube to the top of the container.

To Tube A attach a length of rubber tubing and affix the other end of this tube to the center of large container. Tube B should be attached to a piece of tubing which will be pinched shut after potassium hydroxide is added. The jar can be weighted with sand so that it sinks in a pan of water. Ice can be added to the water to produce varying ambient temperatures within the jar.

As the test animal consumes oxygen, the small container will sink in the water of the large container. The change in levels can be observed on the scale. The markings on the scale can be calibrated by introducing known amounts of air into container through the attached hose. Make several calibrations.

Once the scale is calibrated, you are ready to begin experimentation. Place a test animal in the jar. Stopper and attach the rubber hose of Tube A to the center tube of large container. Add saturated potassium hydroxide to fill bend in Tube B. Stuff cotton into the bent end. Close the other end by pinching the rubber tube with a pinch clamp. The potassium hydroxide in the cotton will remove the carbon dioxide exhaled by the animal. Why is this necessary? Record the original level of air in the small container and allow the test animal to remain sealed in the jar. Add ice to the water surrounding the jar and maintain a constant temperature while oxygen consumption is being recorded.

Determine the volume of oxygen consumed per minute for several ambient



temperatures. This can be calculated from the total oxygen consumed divided by the total time of the experiment.

Example: 30 cc of oxygen in 10 minutes = 3 cc of oxygen consumed per minute.

Determine the minute oxygen consumption rate for 20°, 15°, 10°, 5°, 0° Centrigrade using room temperature as a control. Graph the results.

Discussion:

1. What conclusions can you make about the effect of ambient air temperature on metabolic rate?
2. Which ambient air temperature provided the minimum metabolic rate?
3. What additional factors would have to be considered before this temperature could be used within space suits?

Additional Investigation:

This same apparatus may be used to investigate several space problems. Here are a few problems that are currently being considered by space scientists:

1. To what extent does hypothermia induce drowsiness or sleep?
2. How might the reduced activity associated with hypothermia affect the astronaut's ability to rapidly recover maximum performance efficiency?
3. Could hypothermia provide relief from the psychological and physiological problems associated with long-term confinement and boredom?
4. In what ways could forced astronaut hiberation be beneficial for long space flight?
5. Compare the metabolic effects of hypothermia in homeotherms with poikilotherms as a simulated study of estivation and hibernation.

(This laboratory exercise and many more may be found in the NASA publication *"Space Resources for Teachers—Biology."*)

INDUSTRIAL ARTS AND SPACE TECHNOLOGY

Industrial arts has been defined as the study of tools, materials, processes, products, occupations, and related problems of America's industrial society. As such the profession of industrial arts teaching necessarily concerns itself with those societal developments which have relevance to its area of study. America's space program is such a development. In the effort to increase mankind's knowledge of the heavens and the earth through the use of manned and unmanned spaceflight, America's space program has developed new tools, new materials, new processes, as well as new jobs, unheard of 10 years ago. It has provided great impetus to accelerating advancements and developments in science and technology, and the resulting changes in patterns for living.

Space is the new frontier of science and technology; and if industrial arts is to give students an insight into American industries, teachers must be more concerned with space age technology. The image of industrial arts will be greatly improved in the eyes of the students, parents, administrators, and the lay public when teachers introduce these changes to shop and classroom teaching.

SPACE AGE APPLICATIONS OF INDUSTRIAL ARTS TECHNOLOGY

Drafting:

- Ellipses to show the orbit of a space vehicle, the sun and the planets.
- Booster engines and stages.

Assembly: Draw the following:

- Saturn V Rocket
- Pipe cutting tool
- Portable power tool
- Chart case

Other areas are:

- Electronic drawing
- Sheet metal drawing
- Pictorial drawing
- Architectural drawing
- Structural drawing
- Plumbing drawing
- Charts and drafts

NASA Tech Briefs are available which give detailed information in each of the above areas.

RELATIONSHIP TO INDUSTRIAL ARTS

By this time you have become aware of the magnitude of the aerospace industry; an industry encompassing many people working in many kinds of jobs. This space age industry can be said to be made up of a number of other industrial organizations, as shown in Fig. A. Space vehicles require products made of ceramics, plastic, and metal as well as the power and electronic components. It is evident that industrial arts can make a significant contribu-

tion to understanding the aerospace industry because it, too, is concerned with the same areas, as are shown in Fig. A. Industrial arts students work with the principles and the skills necessary to produce, propel, and control spacecraft. Fig. B shows graphically the kinds of systems present in these crafts and gives further evidence of the many opportunities for industrial arts teachers to help acquaint their students with the products and processes of the space age.

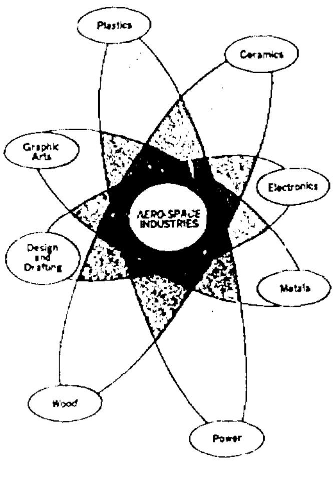


Fig. A

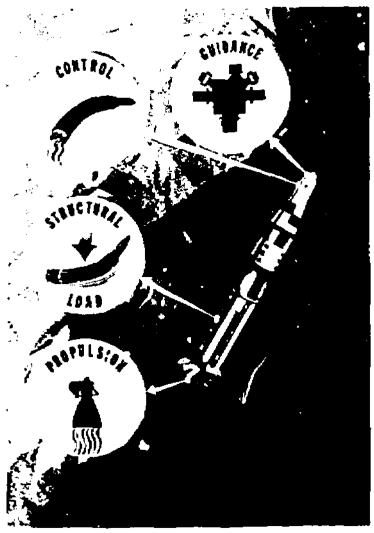


Fig. B

TYPICAL AEROSPACE OCCUPATIONS

aeronautical engineer
aeronautical draftsman
design draftsman
plumbing draftsman
electrical draftsman
mechanical engineer
aircraft designer
machinists
tool and die makers
welders
riveters
heat treaters
jig builders
press and shear operators
model maker
pattern maker
lathe operators
instrument maker
telephone engineer
television repairman
radio electrician
electronic engineer
truck mechanic
diesel mechanic
rocket engine mechanic
photographer
plastics fabricator
ceramics engineer
mock-up builder

A complete coverage of this subject is in the NASA publication "Space Resources for the *High School Industrial Arts.*" "Industrial Arts Resource Units."

PRIVATE PILOT GROUND SCHOOL COURSE

I. Introduction

We feel that the high schools in the state of Oklahoma should make every effort to incorporate aviation and aerospace information into every subject course where it could be inserted by reason of its current interest, its motivating assistance and its logical application in the sequence of study.

In schools which can introduce a separate course in the subject aviation or aerospace, it is recommended that the following be offered in the general education curriculum as an elective, one year (two semester) course.

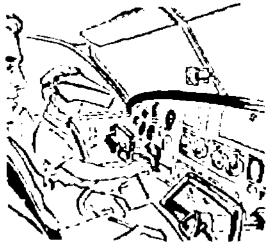
This course is general and introductory or exploratory, not terminal in nature. No prerequisites are set, but the course is designed for use in grades 10, 11, and 12.

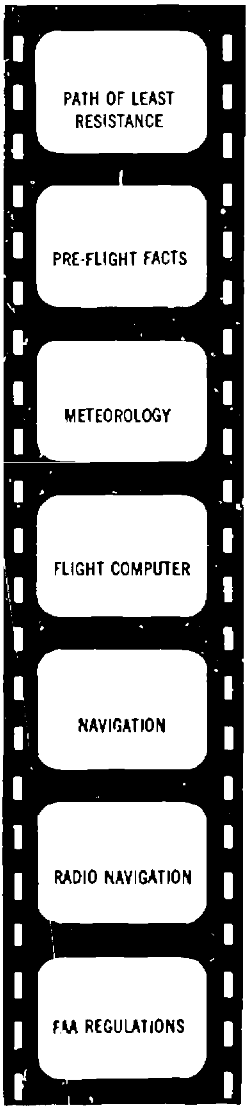
It is further suggested that teacher qualification include some evidence of a *strong* interest in aviation.

II. Objectives

1. To prepare all students so that they may participate in a society strongly influenced by the growth of aviation and space exploration.
2. To introduce the student, through highly motivational subjects of aviation and space, some disciplines of various academic fields. This would include an adequate reading and speaking vocabulary pertinent to aerospace.
3. To furnish all students opportunities for career exploration in aerospace.
4. To provide a flight experience for all students desiring it.
5. To provide some students aviation ground school and/or vocational and technical training in aviation skills.
6. To establish a collection of aerospace materials available to both school and community.

The objectives of this course would be reached by different options in course content. It is recommended that the decision of a specific combination of these options be left to the individual school, dependent upon their facilities.





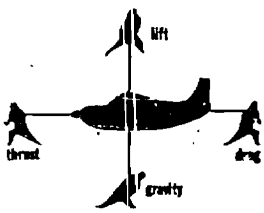
AVIATION EDUCATION

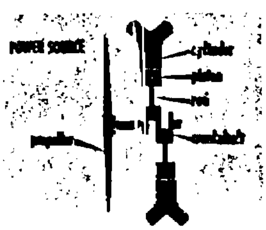
Private

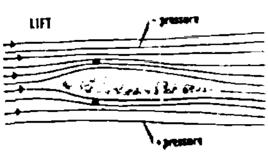
LESSON	*Orientation*
REFERENCES	Sanderson Teacher Education Manual, Flight Instructor's Handbook, Federal Aviation Agency, 1964
OBJECTIVES	Indoctrinate teachers to course methods, teaching techniques, the need for aviation instruction in schools and administrative considerations.
ELEMENTS	Aviation Statistics, Objectives, Organization, Administration, Methodology, Evaluation
SCHEDULE	Lecture :15 minutes Show Sanderson filmstrip, "Path of Least Resistance" :30 minutes Questions :35 minutes
EQUIPMENT	Private Pilot Manual (1) to ea. student DuKane Projector and filmstrip Blackboard TEACHER EDUCATION MANUAL (1) to each student
INSTRUCTOR'S ACTIONS	Orient teachers to Teacher Training Course Show filmstrip Answer questions
STUDENT'S ACTIONS	Register Sign class roster Introductions Ask questions regarding course
EVALUATION	Not required for orientation session

AVIATION EDUCATION

Private







LESSON — *Pre-Flight Facts (Section A)*

REFERENCES — *Private Pilot Manual*, Pre-Flight Facts, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.
Aviation Psychology Manual for Flight Instructors, H. J. Holmes and Thomas Hogan.

OBJECTIVES — Acquaint teachers (students) with aircraft components and the four forces.

ELEMENTS

Aircraft Components	*The Four Forces*
Wing	Lift
Power Plant	Gravity
Empennage	Thrust
Landing Gear	Drag
Fuselage	

SCHEDULE

Introduction of filmstrip, Pre-Flight Facts, Section A	:10
Show filmstrip	:40
Question and answer session	:20

EQUIPMENT — DuKane Projector
Sanderson Filmstrip—Pre-Flight Facts Section A
Blackboard for post filmstrip instruction
Model airplane with moveable controls
Suggested Illustrations for overhead projector:

1. Aircraft Components
2. Wing Structure
3. Power Source
4. Four Forces
5. Propeller
6. Airfoil
7. Lift

INSTRUCTOR'S ACTIONS — Serve as a discussion leader following the showing of the filmstrip.

Typical questions:

What is the main function of the wing?

What is the role of the wing in producing lift?

Illustrate the four forces acting on an aircraft in flight. (Use blackboard)

What are two ways to recover from a stall condition? (Use model plane to illustrate)

What are the four strokes of the engine power cycle?

What is the purpose of the empennage?

Demonstrate or show how the propeller develops "thrust."

(In addition to the above questions, it is suggested that the teachers use the questions outlined in the Sanderson Programmed Learning System)

STUDENT'S ACTIONS

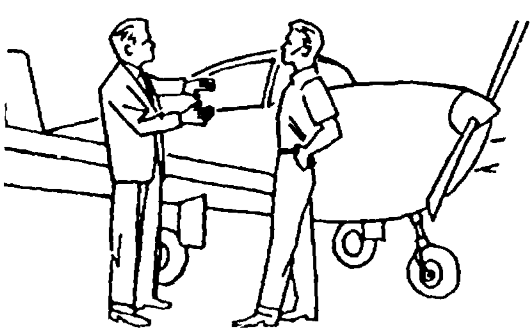
Discuss objectives and resolve above questions.

Review the major concepts presented in the filmstrip.

Demonstrate as many of the concepts as possible using a blackboard, model, or a visual aid.

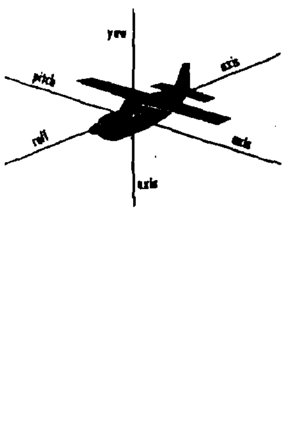
EVALUATION

The lesson is complete when the student teachers can explain, illustrate, describe, define, discuss or formulate the ideas presented and communicate their ideas to others.

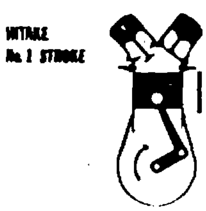


AVIATION EDUCATION

Private



LESSON	*Pre-Flight Facts (Section B)*
REFERENCES	*Private Pilot Manual*, Pre-Flight Facts, Sanderson Films, Inc.—Sec. B *Flight Instructor's Handbook*, Federal Aviation Agency, 1964.
OBJECTIVES	Develop a basic understanding of the three axes: yaw, pitch and roll, along with the aircraft control system, the trim system, vacuum system, and electrical system.
ELEMENTS	*The Three Axes*: Yaw Axis, Pitch Axis, Roll Axis *Aircraft Controls*: Ailerons, Rudders, Elevators, Stabilators, Wing Flaps *Trim Systems*: Trim Tab, Adjustable Stabilizer, Moveable Tail *Vacuum System* *Electrical System*
SCHEDULE	Introduction of filmstrip Pre-Flight Facts, Section B :10 Show filmstrip :40 Question and answer session :20
EQUIPMENT	DuKane Projector Sanderson Filmstrip—Section B Blackboard Model Airplane *Suggested illustrations for overhead projector:* 1. Three Axes 2. Tail Structure (VS) 3. Horizontal Stabilizer 4. Trim Tab—Stabilator 5. More Down Trim 6. More Up Trim 7. Roll Right Bank 8. Roll Left Bank 9. Vacuum System 10. Venturi 11. Electrical System
INSTRUCTOR'S ACTIONS	Serve as a discussion leader following the showing of the filmstrip.



Typical questions:

What is the one point in the airplane's attitude, about which it can be balanced perfectly?

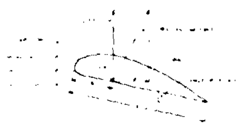
Explain the yaw axis and related control surface.

Describe the pitch axis and related control surface.

Illustrate the roll axis and related control surface.

What are the trim systems provided to minimize elevator or stabilator control pressures?

Review the functions of the trim tab, adjustable stabilizer and moveable tail.



Lift and drag on an airfoil.

Discuss the electrical system. (In addition to the above question, the instructor should use questions outlined in the Sanderson Programmed System)

It is important to learn the relationship of lift to drag in regards to flap settings:

What is the purpose of the wing flaps?

Explain what flap settings are used for take-off and landing.

STUDENT'S ACTIONS

Respond to the above questions correctly; however, if there is some misunderstanding, teacher should be able to resolve points of confusion.

Review material and/or slides which are difficult to understand.

Discuss and review the important points.

EVALUATION

In presenting this unit, the teacher should use the question and answer quiz as much as possible following the showing of the filmstrip. A quiz will check the effectiveness of the lesson, check retention, review the material, build enthusiasm and repeat the important points covered in the filmstrip.

AVIATION EDUCATION

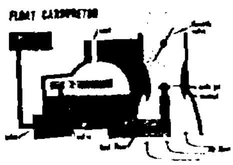
Private

LESSON

Pre-Flight Facts (Section C)

REFERENCES

Private Pilot Manual, Pre-Flight Facts, Sanderson Films, Inc.—Sec. C.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.
Aviation Psychology Manual for Flight Instructors, H. J. Holmes and Thomas Hogan.

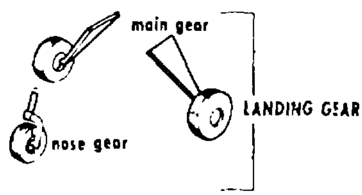


OBJECTIVES

Create an understanding of what the primary function of the fuel system is, how it operates and why there is a need for different types of fuel systems. Acquaint teachers (students) with different types of landing gears and primary function.

ELEMENTS

Fuel System
Gravity Type Fuel System
Fuel Pump Type Fuel System
Fuel Tanks
Fuel Selector Valve
Fuel Strainer
Carburetor
Carburetor Heat System



LANDING GEAR
Conventional Landing Gear
Tri-Cycle Landing Gear
Brake System

Pre-Flight Inspection

SCHEDULE

Introduction of filmstrip	:10
Pre-Flight Facts, Section C	
Show filmstrip	:40
Question and answer quiz	:20

EQUIPMENT

DuKane Projector
Sanderson Filmstrip—Section C

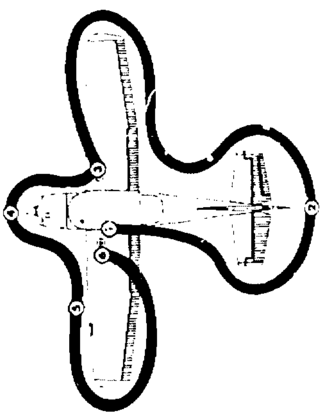
Suggested illustrations for overhead projector:

1. Gravity Fuel System
2. Fuel Pump Type Fuel System
3. Carburetor
4. Carburetor ice
5. Carburetor Heat System
6. Brake System

Pre-Flight inspection checklist
Blackboard

INSTRUCTOR'S ACTIONS

Conduct a question and answer quiz using some of the questions that follow:



What is the primary function of the fuel system?

Name two types of fuel systems.

Where is the fuel strainer located in relation to the fuel system?

Why should not the carburetor heat be used during taxi?

Where is the fuel selector valve located?

Explain the operation of the carburetor.

Name the two basic types of landing gears and the main difference between them.

Discuss the importance of a pre-flight inspection.

STUDENT'S ACTIONS

The students should be able to discuss the above questions.

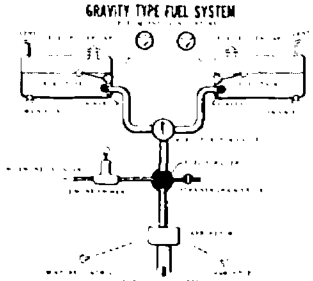
Write in the correct answers to all of the questions outlined in the Sanderson Programmed Learning System following the Pre-Flight Facts Section. Look up wrong answers in Pre-Flight Facts Manual.

EVALUATION

Oral quizzing of Section A, B, & C. Look up wrong answers in Pre-Flight Facts Manual.

Responses to Sanderson Programmed Learning System.

GRAVITY TYPE FUEL SYSTEM



AVIATION EDUCATION

Private

CUMULUS

LESSON — *Meteorology (Section A)*

REFERENCES — Private Pilot Manual, Meteorology, Section A, Sanderson Films, Inc.

Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES — Acquaint the teachers (students) with air masses and other weather phenomena.

ELEMENTS —
United States Weather Bureau
Weather Map
Terminology and Weather
Weather Symbols
Clouds
Atmospheric Pressure
Thunderstorms
Air Masses

CIRRUS

SCHEDULE

Period 1

Introduction of filmstrip Meteorology, Section A	:20
Showing of filmstrip	:40

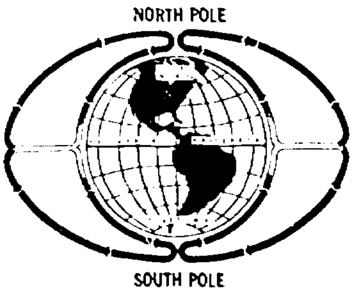
Period 2

Lecture following filmstrip	:20
Manual repeat of film for question and answer quiz	:40

Period 3

Trip to U.S. Weather Bureau & Airport

EQUIPMENT —
DuKane Projector
Blackboard
Actual Weather Maps
The Koch Chart



Suggested Illustrations for overhead projector:

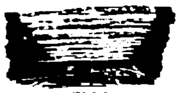
1. Weather Map
2. Speciman (Station Model)
3. Basic Weather Symbols
4. Barometric Pressure in Millibars
5. Thunderstorms
6. High Pressure Area
7. Low Pressure Area
8. Cold Air Profile
9. Warm Front Profile
10. Occluded Front Profile

INSTRUCTOR'S ACTIONS

Arrange for a class tour of the weather bureau and airport if possible. Invite a meteorologist to speak to the class.

Typical questions:

What is the primary function of the weather bureau?


STRATUS

How often during a 24-hour period is weather information plotted on weather maps?

Discuss and explain the various symbols used in the station model.

What are isobars?

Name the two fundamental types of clouds.

Discuss thunderstorms and their stages.

STUDENT'S ACTIONS


NIMBUS

Discuss objectives and resolve questions.

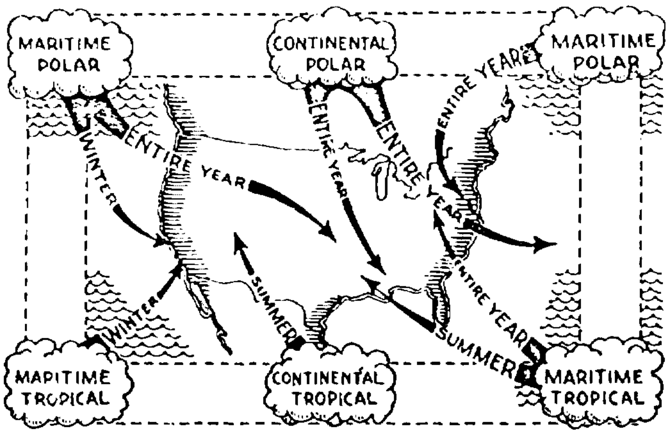
Explain correctly the concepts and ideas presented in this session.

Recognize various frontal conditions and cloud formations.

Compute take-off distance using the Koch Chart.

EVALUATION

Lesson is complete when student can correctly explain each of the key elements listed above.



AVIATION EDUCATION

SEQUENCE REPORT PICTURE
Cold Front approaching
MKC 15+ 132/64/58/131 /992
Cold Front passing
MKC M5 2 TRW 962/56/55/3221
G25/946
After cold front passage
MKC M2 12RW 222/5
/42/3615/ 17

CLEAR: SMOOTH AND GLASSY

RIME: ROUGH AND COURSE

FLYING INTO LOW PRESSURE
(Aircraft Low)

FLYING INTO HIGH PRESSURE
(Aircraft High)

Private

LESSON — *Meteorology (Section B)*

REFERENCES — *Private Pilot Manual*, Meteorology, Sec. A & B, Sanderson Films, Inc. *Flight Instructor's Handbook*, Federal Aviation Agency, 1964.

OBJECTIVES — Acquaint the teachers (students) with fog, icing conditions, density altitude, turbulence, frontal icing and weather reports by radio.

ELEMENTS

Fog	Turbulence
Density Altitude	Frontal Icing
Icing Conditions	Weather Reports by radio

SCHEDULE

Period 1

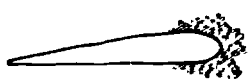
Introduction to filmstrip Meteorology, Section B	:10
Showing of filmstrip	:40

Period 2

Lecture following filmstrip	:10
Manual repeat of film for question and answer quiz	:40

EQUIPMENT — DuKane Projector
Blackboard
Weather Maps (daily fascimile)
Recording of weather reports (local airport)

CLEAR: SMOOTH AND GLASSY



RIME: ROUGH AND COARSE

Suggested illustrations for overhead projector:

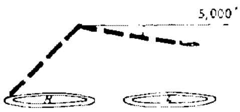
1. Density Altitude
2. Scheduled Broadcast Order
3. Sigmets
4. Thermal Effect on Landing
5. Sea Level Takeoff
6. Koch Chart
7. Turbulence in Cumulonimbus Clouds
8. Effect of Ice
9. Vortex Core

Use following from Sec. A., Meteorology:

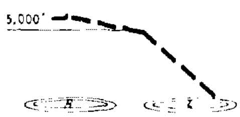
10. Cold Air Profile
11. Warm Front Profile
12. Occluded Front Profile
13. Barometric Scale
14. Warm Front Icing

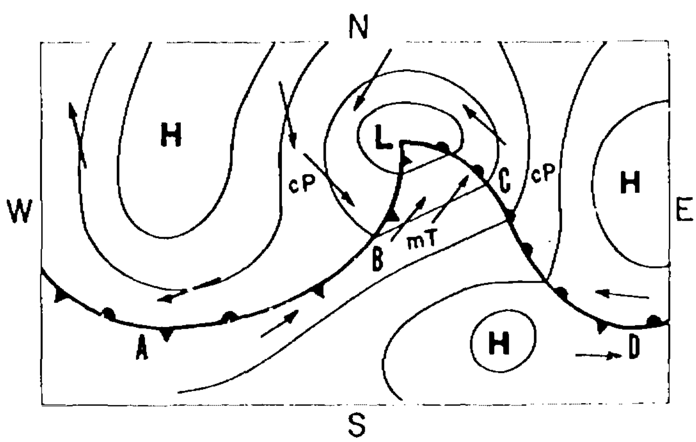
INSTRUCTOR'S ACTIONS	*Typical questions:* What is meant by density altitude? How does density altitude apply to the pilot? Name two kinds of ice and where they will form. Tell about heavy aircraft turbulence. Discuss various radio weather reports. Explain mountain wave.
STUDENT'S ACTIONS	Be able to answer oral questions asked by teachers.
EVALUATION	Paper and pencil test. Oral examination.

FLYING INTO LOW PRESSURE



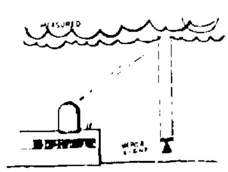
FLYING INTO HIGH PRESSURE





AVI :ION EDUCATION

Private



LESSON

Meteorology (Section C)

REFERENCES

Private Pilot Manual, Meteorology, Section B, Sanderson Films, Inc
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES

Introduce students to the weather advisory service and special advisories available to pilots.

Acquaint students with sequence reports, winds aloft forecasts, and other types of forecasts.

ELEMENTS

Weather Advisory Service
Sequence Reports
Sky Coverage
Ceiling
Visibility
Present weather conditions
Barometric pressure
Temperature and dewpoint
Wind
Altimeter setting
Pilot reports
The Notam Status Code

Winds Aloft Forecast
Terminal Forecasts

SCHEDULE

Period 1

Pre-filmstrip instruction	:20
Sanderson filmstrip Meteorology, Section C	:40

Period 2

Interpretation of Practice Teletype Reports—pages 1-1 to 1-5. Use practice frames, end of Section C filmstrip)	:40
Question and answer session	:20

SEQUENCE REPORTS

```
C29 SA29031200
ROW 70015 072/53/20/3020G29
  /986/OCNL BD
ELP 030 091/54/31/3115/993
GDP AMOS /46/28/2519/
  991/000/
CNM 015+ ⊕ 074/4X11Q
GT HOT
INK S 015+ 075/47/46/2905/
    982/APARANT FROPA
  0540C GND FG DSIPTD
RPDLY/ 312 47 24230→INK↘11/
  IAN
MAF S —X11/2F 055/58/2008/
  979/RICVV1/4 F5
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EQUIPMENT

DuKane Projector
Blackboard
Actual Sequence Reports from local airport-Radio (for listening to "airway" broadcast of weather reports)

Suggested illustrations for overhead projector:

1. Sequence Reports

2. Example of Sequence Report
3. Sky Coverage Symbols
4. Letters to indicate how ceiling is measured
5. Letters to indicate obstruction to visibility
6. Wind Direction Symbols
7. Altimeter Converted to Sea Level
8. Practice Winds Aloft Forecast
9. Practice Frames (Use) C-64 and C-65

INSTRUCTOR'S ACTIONS

Lecture on weather advisory service of general nature.

Involve the students as much as possible in reading practice teletype reports. Assign each student *one* sequence report.

STUDENT'S ACTIONS

Make accurate interpretation of teletype reports of all types
Ability to *read* all sky coverage symbols.

Understand the order of the scheduled weather broadcast.

EVALUATION

Oral reading of sequence report correctly.

Check retention of the subject of meteorology by having the students take Sanderson Films, Inc., Programmed Learning System, Meteorology.

Oral review of test. Look up wrong answers in manual.

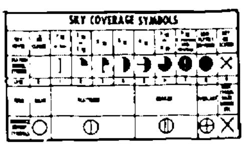
WINDS ALOFT FORECASTS

FD SAT 030550
12Z-24Z TUE

LVL 3000 5000FT 10000FT 15000FT
20000FT 25000FT

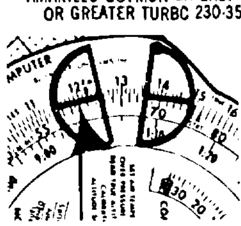
SJT 1720 1920+14 2520+06
2330−04 2335−14 2340−25
18Z 3325 2825+15
MRF 2720+05 2630−05
2635−15 2540−25
HOU 1820 1820+15 2012+07
2512−04 2715−15 2720−25
VCT 1720 1820+16 2015+07
2415−14 2625−25
BRO 1625 1818+17 2308+08
2613−12 2722−24
COT 1625 1625+17 2320+08
2520−02 2420−12 2525−25

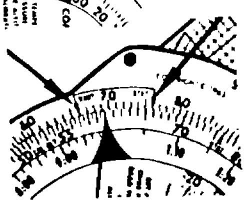
SKY COVERAGE SYMBOLS
USED ON SEQUENCE REPORTS



SEGMENTS

FL GSW 031735
1135C-1535C TUE
SIGMET NR 1. AT 1715 C135 RPRTD
MDT—SVR TURBC 290 OVR
AMARILLO.
OVR NWRN TEX AND OKLA PNHDL
ALG AND 50 MIS EITHER SIDE
OF WINK
AMARILLO GUYMON LN LKLY MDT
OR GREATER TURBC 230-350.





AVIATION EDUCATION

Private

LESSON
Flight Computer (Section A)

REFERENCES
Private Pilot Manual, Flight Computer, Section A, Sanderson Films, Inc.

Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES
Use of flight computer in pre-trip planning and to compute in-flight aircraft problems.

Develop greater confidence in flying through a good understanding of the computer.

ELEMENTS
Flight Computer
Calculator side
Changing values
Speed index
Multiplication or division index
Time and distance problem
Fuel consumption

SCHEDULE

Period 1
Introduction to computer :10

Showing of filmstrip, Flight Computer, Section A :40

Period 2
Lecture on computer use :15

Work Practice Time and Distance Problems, page A-5

Period 3
Work Practice Fuel Consumption Problems, page A-8, A-9, A-10 :30

Work Review Problems, Page A-10 :15

EQUIPMENT
DuKane Projector
Sanderson Flight Computers (one for each student)
Blackboard

Suggested illustrations for overhead projector:

1. Computer side of Sanderson Flight Computer (Moveable Scales)
2. Problem Logs (Draw on Clear Overhead Transparency)

INSTRUCTOR'S ACTIONS

Lecture on the use of Flight Computer

Provide opportunity for students to solve problems presented in Sanderson Films, Inc., booklet entitled, "Flight Computer."

Assist those students who have difficulty in problem solving.

Review key points brought out in filmstrip.

STUDENT'S ACTIONS

Solve all flight computer problems in manual, Section A, Pages A-5 to A-10.

Develop correct understanding of the basic operation of the flight computer.

Explain what the "A", "B", "C" scales of computer are used for.

EVALUATION

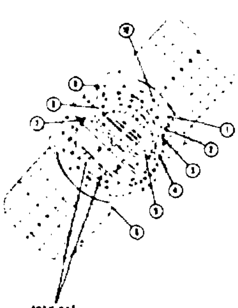
Demonstrate ability to solve all computations presented in Section A with the use of a Sanderson Flight Computer.

Demonstrate the ability to explain the use of a flight computer to others.

PRACTICE PROBLEMS — TRUE HEADING AND GROUND SPEED

1. True course—310°; T. A. S.—120 m.p.h. wind velocity—16 m.p.h.; wind direction—180°; what is the true heading and ground speed?__________
2. True course—178°; T. A. S.—135 m.p.h.; wind velocity—23 m.p.h.; wind direction—45°; what is the true heading and ground speed?__________
3. True course—65°; T. A. S.—155 m.p.h.; wind velocity—20 knots; wind direction—Northwest; what is the true heading and ground speed?__________
4. True course—West; T. A. S.—130 knots; wind velocity—18 knots; wind direction—344°; what is the true heading and ground speed?__________
5. True course—95°; T. A. S.—111 m.p.h.; temperature—+25° C.; altitude—7,500 feet; wind velocity—10 knots; wind direction—360°; what is the true heading and ground speed?__________

COMPUTER SIDE OF SANDERSON FLIGHT COMPUTER

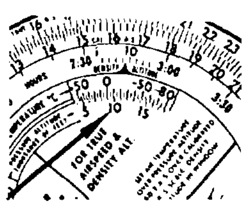


1. "A" SCALE—(Miles, miles per hour, gallons, gallons per hour, true airspeed, and true altitude.)
2. "B" SCALE—(Time in minutes, calibrated altitude, and calibrated airspeed.)
3. "C" SCALE—(Time in hours and minutes)
4. DENSITY ALTITUDE WINDOW
5. PRESSURE ALTITUDE WINDOW
6. TEMPFRATURE CONVERSION SCALE
7. SPEED INDEX
8. AIR TEMPERATURE WINDOW
9. NAUTICAL—STATUTE CONVERSION ARROWS
10. UNIT INDEX FOR MULTIPLICATION AND DIVISION

COMPUTER SIDE OF SANDERSON FLIGHT COMPUTER

AVIATION EDUCATION

Private



LESSON — *Flight Computer (Section B)*

REFERENCES — *Private Pilot Manual*, Flight Computer, Section B, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES — Solving of true airspeed problems using the flight computer.

Changing nautical values to statute equivalents with the use of the computer.

Finding answers to multi-part problems.

ELEMENTS — *Flight Computer*

T.A.S.	Statute miles
Nautical values	Multi-part problems

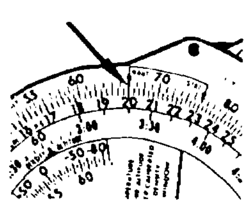
SCHEDULE

Period 1

Introduction of filmstrip Flight Computer, Section B	:05
Showing of filmstrip	:40

Period 2

Lecture on Computer use	:15
Problem solving	:50



EQUIPMENT — DuKane Projector
Blackboard
Sanderson Flight Computers (one for each student)

Suggested illustrations for overhead projector:

1. Computer Side of Sanderson Flight Computer (Moveable Scales)
2. Problem Logs (Draw on Clear Overhead Transparency)

INSTRUCTOR'S ACTIONS — Introduce students to other uses of flight computer.

Assist students with problem solving.

STUDENT'S ACTIONS — *Know* how to compute T.A.S., conversion of nautical miles to statute and statute to nautical miles.

Explain correct use of the computer

EVALUATION

Require students to answer correctly all practice multi-part problems on page B-5.

Instructor should help answer student questions during problem solving period.

PRACTICE MULTI-PART PROBLEMS

1. Wind—0 m.p.h.; ground speed—120 m.p.h.; distance—320 miles; fuel consumption—9 g.p.h.; how much fuel will be burned?____

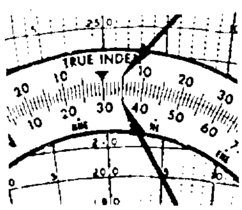
2. Altitude—7,500 feet; I.A.S.—150 m.p.h.; temperature—+15° C.; distance—256 miles; fuel consumption—11.5 g.p.h.; wind 0 m.p.h.; how much fuel will be burned?____

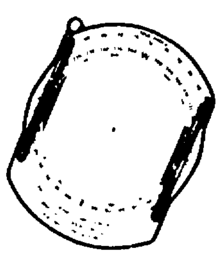
3. Altitude—9,000 feet; I.A.S.—115 m.p.h.; temperature of—10° C.; distance—335 miles; fuel consumption—8.5 g.p.h.; wind —0 m.p.h.; how much fuel will be burned?____

4. Ground speed—135 m.p.h.; wind —0 m.p.h.; temperature—+20° C.; altitude—9,000 feet; distance—425 miles; fuel consumption—12 g.p.h.; how much fuel will be burned?____

AVIATION EDUCATION

Private





LESSON — *Flight Computer (Section C)*

REFERENCES — *Private Pilot Manual,* Flight Computer, Section C, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES — Determine what effect winds have on the aircraft and what should be done to correct for these winds.

Know how to use the "Wind Side" of the computer.

Finding of ground speed and true heading.

Converting of Fahrenheit to centigrade.

ELEMENTS — *Flight Computer*

Sliding Grid	Fahrenheit Scale
Azimuth	Centigrade Scale
True Index	

SCHEDULE

Period 1	
Introduction of filmstrip Flight Computer, Section C	:05
Showing of filmstrip	:40
Period 2	
Student practice	:50

EQUIPMENT — DuKane Projector
Blackboard
Sanderson Flight Computers (one for each student)

Suggested illustrations for overhead projector:

1. Wind side of Flight Computer (Sliding Grid)
2. Ground Speed Example
3. Example TC—TH
4. Problem Logs (Draw on clear overhead transparency)

INSTRUCTOR'S ACTIONS — Review the parts of the computer to the students.
Relate computer usage to piloting an airplane.
Assist students with problem solving.

STUDENT'S ACTIONS

Find correct answers to practice problems listed in Flight Computer, Section C, Appendix 1, page 1-1 in manual.
Describe the correct use of the computer in solving the various problems.

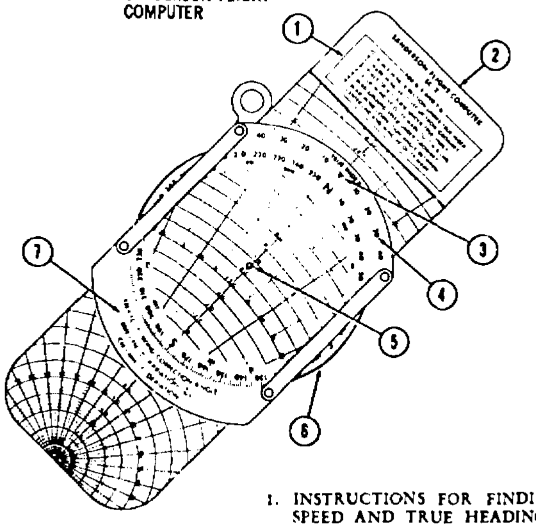
PROBLEM LOG

tas	dist.	time	gph	fuel
?	455	?	10	?

EVALUATION

Administration of Flight Computer Programmed Learning Tests at the end of the lesson on computers.
Discuss answers to Programmed test questions and look up answers in manual.

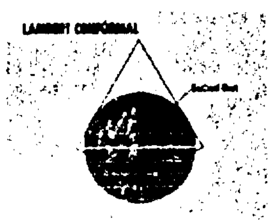
WIND SIDE OF SANDERSON FLIGHT COMPUTER



1. INSTRUCTIONS FOR FINDING GROUND SPEED AND TRUE HEADING.
2. SLIDING GRID
3. TRUE INDEX
4. WIND CORRECTION ANGLE SCALE
5. GROMMET
6. AZIMUTH
7. INSTRUCTIONS FOR DETERMINING TRUE HEADING, MAGNETIC HEADING, AND COMPASS HEADING

AVIATION EDUCATION

Private



LESSON

Navigation (Section A)

REFERENCES

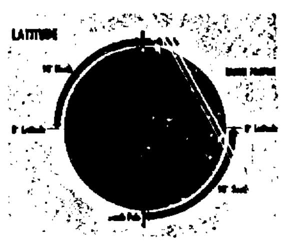
Private Pilot Manual, Navigation, Section A, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES

To familiarize students with navigation charts.
To know how to select charts, read chart symbols, air traffic control symbols and aeronautical and topographical symbols.

ELEMENTS

WAC Charts
Sectional Charts
Latitude and Longitude Chart Symbols
Radio Facilities



SCHEDULE

Period 1

Lecture on introduction to Navigation	:20
Showing of filmstrip, Navigation, Section A	:40

Period 2

Discussion of filmstrip information	:50

EQUIPMENT

DuKane Projector
WAC Charts
Sectional Aeronautical Charts
Blackboards
Suggested illustrations for overhead projectors:
1. Sectional Chart
2. Longitude
3. Latitude
4. Aeronautical Symbols
5. Topographical Symbols
6. Cruising Altitudes
   Flight Levels

INSTRUCTOR'S ACTIONS

Present a general lecture on Section A of Navigation, using as many charts and other aids as possible.
Develop a list of questions using Sanderson Private Pilot Manual.
Have the students interpret the various chart symbols during the question and answer quiz.

STUDENT'S ACTIONS

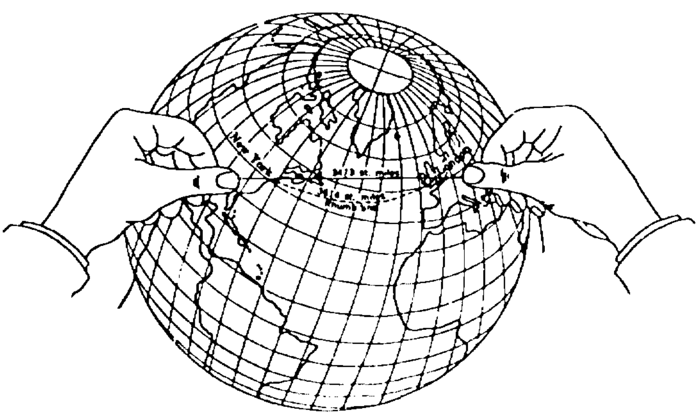
Correct *interpretation* of all chart symbols.

Understand the major differences between the WAC Charts and Sectional Charts.

EVALUATION

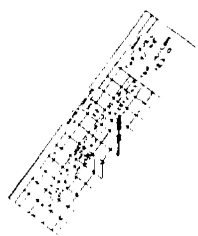
Oral quizzing by instructor.

Lesson is complete when student can retain the information presented during the filmstrip presentation and follow-up discussion.



AVIATION EDUCATION

Private



LESSON — *Navigation (Section B)*

REFERENCES — *Private Pilot Manual*, Navigation, Section B, Sanderson Films, Inc. *Flight Instructor's Handbook*, Federal Aviation Agency, 1964.

OBJECTIVES — Students should know how to use all of the flight planning aids.

Knowledge of all of the steps necessary in pre-trip planning such as drawing a course, selecting check points, measuring the true course and other computations.

ELEMENTS — *Navigation Planning Aids*
Flight Computer
Navigation Plotter
Airman's Information Manual

SCHEDULE

Period 1

Introduction	:10
Showing of filmstrip, Navigation, Section B	:40

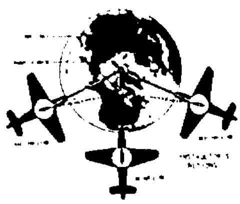
Period 2

Question and answer quiz	:50

Period 3

Pre-trip planning session	:50

EQUIPMENT — DuKane Projector
Sectional Aeronautical Charts
Navigation plotter for each student
Flight Computers for all students.
Airman's Information Manual



Suggested illustrations for overhead projectors:

1. Pre-Flight
2. Notices to Airmen
3. Airport Directory
4. Airport/Facility Directory
5. Magnetic North Pole
6. East Variation
7. West Variation (Instructors can use clear transparencies for drawing additional items for this section).

INSTRUCTOR'S ACTIONS — Serve as discussion leader following the filmstrip showing.

Assist students in planning a trip using all of the flight planning aid.

Build question and answer session around overhead transparencies.

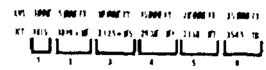
STUDENT'S ACTIONS

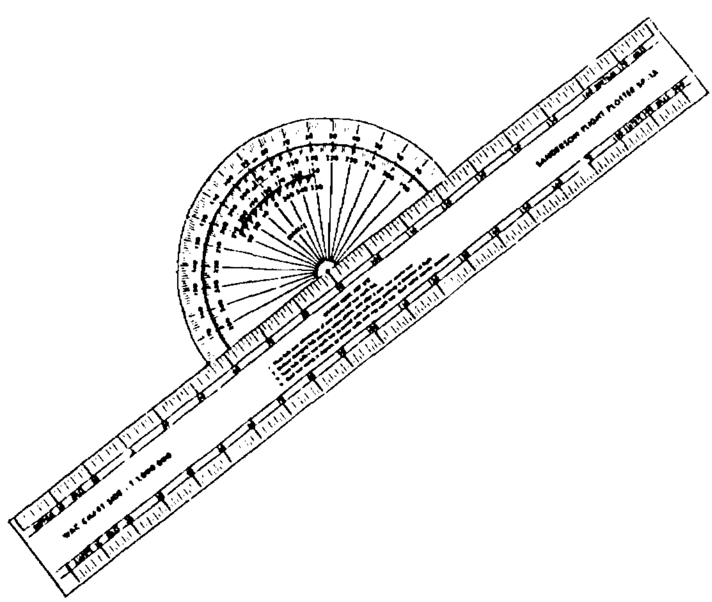
Resolve any questions during the session following the showing of the filmstrip.
Plan a trip using all of the flight planning aids. (Omit radio frequencies and airport data.)

EVALUATION

Student demonstrations of ability to plan a trip using flight computer, navigation plotter, Airman's Information Manual and other manuals.

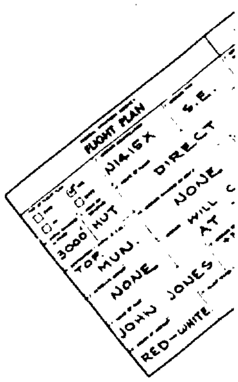
PRACTICE WINDS ALOFT FORECAST





AVIATION EDUCATION

Private



LESSON — *Navigation (Section C)*

REFERENCES — *Private Pilot Manual*, Navigation, Section C, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

OBJECTIVES — Knowing how to obtain radio frequencies and other airport data from charts and manuals.
Provide students an actual flight experience with a well-qualified pilot who will show how to plan a flight plan, fly a short cross-country trip, communicate with ground control and tower, compile a flight log and close flight plan upon arrival.

ELEMENTS — Radio Frequencies and Airport Data
Flight Plan
Flying the Trip
Pre-Takeoff
Enroute
Arrival
After Landing

SCHEDULE

Period 1	
Introducing remarks	:10
Showing of filmstrip Navigation, Section C	:40
Period 2	
Discussion and questions	:50
Periods 3 & 4	
Trip to airport and flight	1:30

EQUIPMENT — Sectional Charts
Flight Plan Forms
Navigation Logs
Flight Computers
Navigation Plotters
Airplanes
Airman's Information Manual

Suggested illustrations for overhead projector:

1. Teachers can use computer transparency, flight plan forms, navigation logs and plotters, etc.

INSTRUCTOR'S ACTIONS — Conduct question and answer session. Develop questions.

Administer Navigation Programmed Learning System test.

Plan a trip to airport, in addition, arrange for airplanes and pilots to fly a short cross-country trip to a nearby airport.

STUDENT'S ACTIONS

Demonstrate ability to find radio frequency and airport data in Airman's Information Manual and navigation charts.

Fill out flight plan and know how to file it.

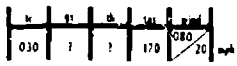
Assist pilot with navigation and check points during the trip, also, filing of flight plan.

EVALUATION

Determine the amount of the subject retained by the students by administering test on Navigation at the end of Section C.

Evaluate student's ability to use sectional charts, airport data, etc., during actual flight if possible.

FINDING GROUND SPEED AND TRUE HEADING

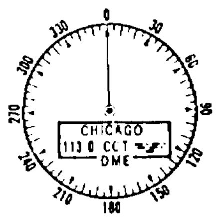


AVIATION EDUCATION

Private

LESSON *Radio Navigation (Section A)*

Private Pilot Manual, Radio Navigation, Section A, Sanderson Films, Inc. *Flight Instructor's Handbook*, Federal Aviation Agency, 1964.



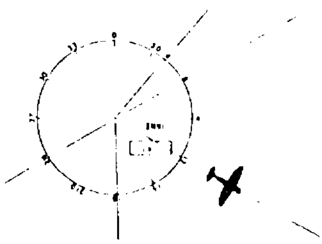
Bearings are magnetic at the station.
DME where shown indicates Distance Measuring Equipment.

Present advantages of the Omni Navigational Aid System.
Ways of determining position using the Omni radio equipment.
Methods of intercepting a radial.

Omni Navigation
Omni signal
Omni equipment
Flying inbound and outbound on a radial
Homing
Position Fixing
Intercepting a radial
Omni disadvantages

Period 1
Introductory remarks :10
Showing of filmstrip :40
Radio Navigation, Section A

Period 2
Questions and answer session :50
(Use pictures in filmstrip for this part.)



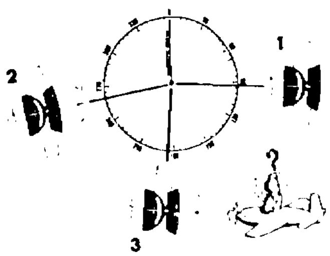
DuKane Projector
Blackboard
Sectional Aeronautical Charts
Table of VHF Reception Distances

Suggested illustrations for overhead projector:

1. Omni Station
2. Basic Indicators
3. Transparency of Omni Station with several radials and a miniature plane developed to be placed on overhead projector for the purpose of testing students. (Use illustrations in text, Pages A-7 and A-12.)

Serve as discussion leader following the showing of the filmstrip.

Demonstrate Omni equipment (Use overhead projector.) Present various



positions of the plane from Omni station and CDI indications.

Typical questions:

How many courses are available to a pilot using the Omni Navigational Aid System?

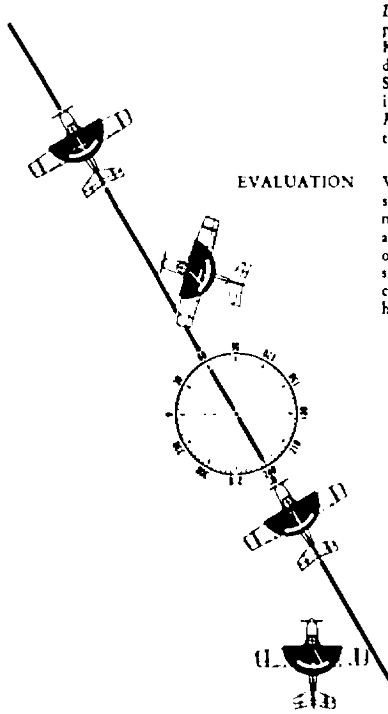
When the left-right needle is centered while on a course, will the wind drift the plane in either direction?

Are omni bearings true or magnetic bearings?

Where can a pilot obtain the information about a particular Omni Station (such information as the name of the station and its frequency?)

Name two types of Omni Stations.

What are the three basic indicators on the Omni equipment?



STUDENT'S ACTIONS

Explain the use of Omni as a radio navigation aid.

Determine the position of the airplane from the station.

Know how to locate himself when in doubt about his position on a flight.

Student *demonstration* of ability to intercept a radial.

Knowledge of VHF reception distances.

EVALUATION

While presenting this unit, the instructor should use the discussion method to determine the retention and knowledge of the subject matter on the part of the students. Students should be able to explain the basic concepts of the Omni equipment and how it operates.

AVIATION EDUCATION

Private

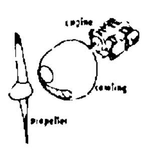
LESSON

F. A. Regulations (Section A)

Private Pilot Manual, F. A. Regulations, Section A, Sanderson Films, Inc.
Flight Instructor's Handbook, Federal Aviation Agency, 1964.

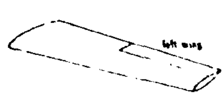
To develop knowledge of Part 61 of the Federal Aviation Regulations, certification of pilots and flight instructors.

	61.3	Certificates and ratings required
	61.5	Application and issue
	61.7	Temporary certificate
	61.9	Duration of certificates
	61.11	Exchange of certificate
	61.13	Change of name
61.15	61.17	Aircraft ratings
	61.21	Prerequisites for flight test
61.23	61.25	Flight tests
	61.27	Retesting after failure
	61.39	Pilot logbooks
	61.43	Medical certificate
61.61	61.73	Student Pilots
61.81	61.101	Private Pilots

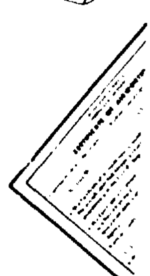


Period 1
Introductory remarks :10

Show filmstrip :40
F. A. Regulations, Section A



Period 2
Review session :50



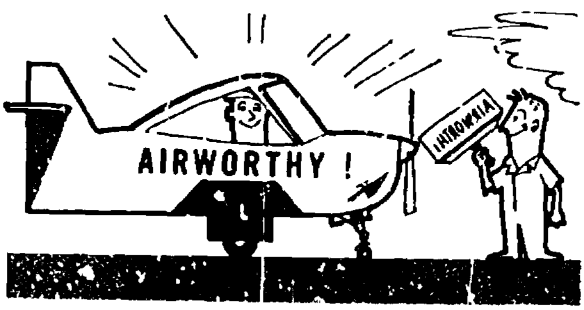
DuKane Projector
Blackboard
Arrange for resource person (FAA representative)

Introduce filmstrip

Conduct question and answer session.

Typical questions:
What is the minimum age at which a student pilot is authorized to pilot an airplane?
What are the requirements for solo flight?
What is the duration of a student pilot certificate?
At what age can a student pilot become eligible for a private pilot certificate?

What class medical certificate is required for a private pilot?
In terms of minimum flight experience requirements for a private certificate, how many hours of dual instruction and solo flight time are required?
Where is acrobatic flight prohibited?
What are the right-of-way rules for an aircraft in distress?
Can a private pilot carry passengers for hire?



AVIATION EDUCATION

Private

LESSON — *F.A. Regulations (Section B)*

REFERENCES — *Private Pilot Manual*, F. A. Regulations, Section B, Sanderson Films, Inc. *Flight Instructor's Handbook*, Federal Aviation Agency, 1964.

OBJECTIVES — Understand definitions listed in Appendix 1 of F. A. Regulations, Section B, Sanderson Films Private Pilot Manual.

Develop knowledge of all flight rules governing the operation of aircraft within the U. S. (Private pilot) This includes basic VFR minimums.

Review of rules governing the maintenance of U.S. registered civil aircraft and rules for operating civil aircraft in a defense area, or into, within, or out of the U.S. through air ADIZ.

SCHEDULE

Period 1	
Introduction	:05
Showing of filmstrip F. A. Regulations, Section B	:40
Period 2	
Question and answer session	:50
Period 3	
Examination	:50

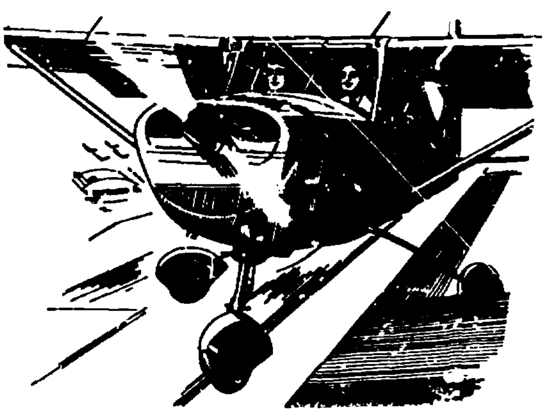
EQUIPMENT — DuKane Projector
Blackboard

INSTRUCTOR'S ACTIONS — Arrange for a representative of the FAA to assist with discussion session. Administer an examination on Sections A and B of the Federal Aviation Regulations. (Instructor can use test questions from the Sanderson Programmed Learning System.)

STUDENT'S ACTIONS — *Read* aloud appropriate sections from F. A. Regulations, Section B.
Participate in discussion.
Demonstrate general knowledge of Federal Aviation Regulations.

EVALUATION — Ability to explain correctly F. A. Regulations to other students.
Written examinations, Sections A & B.

Bibliography



FILMS

Hint: Always order free films on school stationery.

Hint: Always ask for their "Film Catalog."

P — Primary, I — Intermediate, Sd. sound, color, b-w

Britannica Press, 425 North Michigan Avenue, Chicago, Illinois 60611.

"An Airplane Trip by Jet" — 11 min. color, P. I., 1961.
"Sound and How It Travels" — 11 min. b-w P. 1963.

Cenco Educational Films, Chicago, Illinois, 1963.

"The Moon" — 14 min. sd. color. P. I.

Churchill Films, 662 North Robertson Boulevard, Los Angeles, California 90069.

"Airport in the Jet Age" — 11 min. Color. P. I. 1962.

Coronet Films, Chicago, Illinois

"Aristotle and the Scientific Method" -- 1959, 1½ min. sd. color. P. I.
"Beyond our Solar System" — sd. 11 min. b-w. P.
"What Do We See in the Sky?"
"Airplane: Principle of Flight"
"How Weather Helps Us"
"How Air Helps Us"
"Billy's Helicopter Ride"

Encyclopaedia Britannica Films, Wilmette, Illinois

"Myth, Superstition and Science" — 1960, 13 min. sd. color, P. I.
"Air and What It Does"
"Airplane Trip by Jet"
"A Space Flight Around the Earth"
"Airplanes: How They Fly"
"What Makes Clouds"
"Whatever the Weather"

FAA Film Library AC-921, P.O. Box 25082, Oklahoma City, Oklahoma 73125.

"The Flight"

Film Associates of California, Los Angeles, California

"Discovering Numerals" — 1964, 9 min. sd. color. P.
"Clouds"
"Snow"

McGraw-Hill Book Company, Text-Film Division, 330 West 42nd St. New York 10036

"Airplanes and How They Fly" — 11 min. b-w.
"Air All Around" — 8 min. b-w
"What Makes Rain"

National Aeronautics and Space Administration, NASA Central Film Depository,
1411 South Fern Street, Arlington, Virginia 22202.
"Apollo 11" and many others.

Piper Aircraft Corporation, Director of Aviation Education, Lockhaven, Pennsylvania 17745
"Don't Tell my Wife" — 19 min. color, sd.
"Wings to the Bahamas" — 26½ min. color, sd.
"Wings to Alaska" — 26½ min. color, sd.
"The Sky is Yours" — 26½ min. color, sd.
"The Flight of Bluebird II" — 26 min. color, sd.
"This Could Be You" — 27½ min. color, sd.

Shell Oil Company, 450 N. Meridian, Indianapolis, Indiana 46204
"How an Airplane Flies"

Sigma Educational Films, 11717 Ventura Boulevard, Studio City, California 91604
"The Community Airport" — 1966, color, P.

Transportation, Department of Federal Aviation Administration, Film Library, AC-921,
Aeronautical Center, P. O. Box 25082, Oklahoma City, Oklahoma 73125
"Best Investment We Ever Made" — 24 min. color, el A.
"Dulles International — Port of the Future" — 1965, 14 min., color, el.
"Flight" — 28 min. color, P.A., 1962.
"How an Airplane Flies" — 18 min. color, P A. 1968
"Other Passenger, The" — 30 min. color, P.A. 1965
"Plane is Born, A" — 27 min. color, P.A. 1968
"Sonic Boom and You" — 10 min. color, P.A. 1968
"Traveler Meets Air Traffic Control, A" — 33 min. color, P.A. 1963

United Airlines, 230 W.O.W. Building, 14th and Farnam St., Omaha, Nebraska 68102
"Ready for Flight"
"Stewardess Story"

Walt Disney Films, 800 Sonora Avenue, Glendale, California 91201
"Man in Flight"

RESOURCE MATERIALS

Hint: For best results, order free materials on school stationery

Hint: *Always* ask for their "List of Publications"

Charts and Pictures

Apollo Spacecraft Model Kit #H-1836
Revell, Inc.
4223 Glenco Avenue
Venice, California 90292 ($1.50)

McDonnell Douglas Corporation
Director of Public Relations
3000 Ocean Park Boulevard
Santa Monica, California 90406

Steps to the Moon Kit #9030
Chart 38" x 26"
Hammond Inc.
Maplewood, New Jersey 07040 ($1.00)

Ask to be put on a mailing list
"NASA Facts" — Film Catalog Free
c/o NASA Central Film Depository
1411 South Fern Street
Arlington, Virginia 22202

"Apollo Saturn Lunar Landing"
Space Division
North American Rockwell
Aero Commander
Oklahoma City, Oklahoma

Suggested Sources of Airplane Photographs (When writing for photos ask for other free materials.)

American Airlines, Inc.
633 Third Avenue
New York, New York 10017

Beech Aircraft Corp.
Public Relations Department
9709 E Central
Wichita, Kansas 67201

Boeing Company
Attn.: Public Relations
Box 3707

Seattle, Washington 98124

Cessna Aircraft Company
P. O. Box 1521
Wichita, Kansas 67201

Pamphlets

"Aircraft Profiles"
Suite 310 Shoreham Building
806 Fifteenth Street, N.W.
Washington, D.C. 20005

"The World of Beechcraft"
Beechcraft Aircraft Corp.
Wichita, Kansas 67201

Teacher's Kit Material
Cessna Aircraft Company
Air Age Education Division
Wichita, Kansas 67201

"Lockheed Pathway to the Stars" Free
Corporate Offices
P. O. Box 551
Burbank, California 91503

"Meet the 10 Place Learjet 25"
Lear Jet Industries, Inc.
P. O. Box 1280
Wichita, Kansas 67201

NASA Facts Free

"Journey to the Moon"
c/o NASA Central Film Depository
1411 South Fern Street
Arlington, Virginia 22202

Model Aircraft Lab

Civil Air Patrol
National Headquarters
Maxwell AFB, Alabama 36112
(Building and Flying Paper Airplanes)

List of films and other materials on weather
(Give your grade level)
User Service Representative
Weather Bureau Central Region
601 East 12th Street
Kansas City, Missouri 64106

Freedom in Space
Weather Satellite
Radio Corporation of America
Defense Electronics Products
Camden, New Jersey

What's the Weather
Air France
683 Fifth Avenue
New York, New York 10022

The Story of Safety in the Skies
FAA
Distribution Section TAD-484
Washington, D.C. 20553
(Cartoon Booklet — Traffic Control)

How to Introduce the Study of Outer Space in Grades K-6
American Education Publications
55 High Street
Middletown, Connecticut 06458

Recommended Books on Space Science and Astronomy
Smithsonian Astrophysical Observatory
60 Garden Street
Cambridge, Mass. 02138

Model Rocketry Information
Estes Industries, Inc.
Box 227
Penrose, Colorado 81240

Model Rockets
Centuri Engineering Company
Box 1988
Phoenix, Arizona 85001

"Air Transportation and World Progress" Free
Oklahoma Aeronautics Commission
510 Sequoyah Memorial Building,
Oklahoma City, Oklahoma 73105

Ask to be put on mailing list
Sanderson Film Co.
P. O. Box 13121
Wichita, Kansas 67213

Air World Education Free
Trans-World Airlines
605 Third Avenue
New York, New York 10016

"The Age of Flight"
United Aircraft
East Hartford, Conn. 06108

"The Story of Flight and Air Transportation" Free
United Air Lines
School and College Dept.
P. O. Box 66141
Chicago, Illinois 60666

"Space, the New Frontier"
"Fifty Years of Aeronautical Research"
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

The DC-8 Jet Mainliners — S Study of Important Parts

United Airlines
School and College Service
O'Hara International Airport
P. O. Box 8276
Chicago, Illinois 60666
(Folder illustrates parts of large jet)

Delta Airlines, Inc.
Public Relations Department
Atlanta Airport
Atlanta, Georgia 30320

Historical Airplane Pictures
TRW, Inc.
Corporate Public Relations
23555 Euclid Avenue
Euclid, Ohio 44117

Journey to the Moon NF-40
(Color wallsheet)
NASA Manned Spacecraft Center
Houston, Texas 77058

Moon Exploration
11" x 14" Captioned prints
Communicative Arts
Box 11017
San Diego, California 92111

Map of the Moon
Stafford Industries, Inc.
P.O. Box 702
Devon, Pa. 19333

Pan America's Flying Clipper
Educational Department
Pan American Bldg.
New York, New York

Pathway to the Stars
Lockheed Aircraft Corporation
Box 551
Burbank, California 91503

Space Travel (Chart 54" x 44" color)
(sequence of events that lead man into space)
Denoyer-Geppert Co.
5235 Ravenswood Avenue
Chicago, Illinois 60666

Airworld Education Study Series
Trans World Airlines
605 Third Avenue
New York, New York 10016

Story of Flight and Air Transportation
United Air Lines
School and College Department
Box 66141, Chicago 60666

Trip to the Moon and Return
Chart 23" x 29"
Communicative Arts
Box 11017
San Diego, California 92111

Wall Charts, instrument panel.
aircraft panel
Piper, Aircraft Corporation
Attention: Director, Aviation Ed.
Lockhaven, Pennsylvania 17745
(also motion pictures)

Suggestions for Commemorating Wright Brothers' Day — Free — Elem. Level
National Aerospace Education Council
Room 310, Shoreham Building
806 15th Street, N. W.
Washington, D.C. 20005

The Planetarium
An elementary school teaching resource

Order from:
Educational Programs and Services
Public Affairs Office
NASA Manned Spacecraft Center
AP-4
Houston, Texas 77058

Aerospace Units for Elementary Science Classes, Second and Third Primary Grades
The total unit includes material covering kindergarten through sixth grade.
However, the above portion is only for second and third grades.
Reprinted by:
Federal Aviation Administration
Aviation Education
Office of General Aviation Affairs
Washington, D.C. 20590

Teachers Guide for SST . . T . . T (Sound, Sense, Today, Tomorrow, Thereafter) 72pp.
Order from:
Office of General Aviation Affairs
Federal Aviation Administration
Department of Transportation
Washington, D.C. 20590

Introducing Children to Space
A space handbook for teachers, grades K to 6, featuring maturity levels 5 through 11 years old. Projects and illustrations are described at each age level. 168 pp.

Order from:
Superintendent of Documents
Government Printing Office
Washington, D.C. 20402

CHILDREN'S BOOKS

Look to the Sky
An aviation reading readiness book for primary grades with suggestions for teachers. 32 pp.

Aviation Activities
A workbook for primary children. Coloring cut-outs, word matching games, etc. 40 pp.

You and Space
A primary grade supplementary reader to develop concepts of space and space travel. Illustrated. 32 pp.

Earth and Space Guide for Elementary Teachers
Based on questions children have asked about the earth, sun, moon, stars and space. 83 pp.

Aerospace Arithmetic
Grades 3 through 6. 16 pp.

Above-listed books and many others may be obtained from:

National Aerospace Education Council
806 Fifteenth Street, N.W.
Washington, D.C. 2000[illegible]

The New Seeing Why, Dowling, Thomas L., et al. Philadelphia: Winston and Co.
The First Book of Airplanes by Jeanne Bendick. New York, Franklin Watts, Inc. 1958.
How and Why Wonder Book of Weather by George Bonsall. Wonder Books, N.Y.
The Big Book of Real Helicopter. New York: Grossett and Dunlap.
Off Into Space by Margaret O. Hyde. New York: American Book Co.
Satellites in Outer Space, Isaac Asimov. New York: Crowell Company, 1958.
The First Book of Space Travel, Jeanne Bendick. Franklin Watts, Inc., 1963 (68). 48 pp.
What Is the Moon Like, Franklin M. Branley. New York: Thomas Y. Crowell, 1961, 48 pp.
Jets of the World, C. B. Colby, New York: McCann, Inc., 1966.
Peter and the Rocket Trip, Hazel W. Carson. Chicago: Beckley-Cardy Company, 1955.
Space for Everyone, Philip S. Egan. Chicago: Rand McNally & Co., 1961.
The Moon for Young Explorers, Carroll Lane Fenton. New York: John Day and Company, 1963, (64 pp.)
You Will Go to the Moon and the Stars, Mae and Ira Freeman. New York: Random House, 1959.
Fly High Fly Low, Mae and Ira Freeman. New York: The Viking Press, 1957.
I Want to be a Pilot, Carla Greene. Chicago: Children's Press, 1957.
The Buttons and the Whirleybird, Edith S. McCall. Chicago: Benefic Press, 1959.
This Is Cape Kennedy, Miroslav Sasek. Dallas: MacMillan, 1964.
Jeepers, There's a Jet, Thelma Shaw. Chicago: Albert Whitman and Co., 1960.
Let's Find Out About the Moon, Martha Shapp. New York: Franklin Watts, 1965, 55 pp.
The Moon Jumpers, Janice Udry. New York: Harper and Brothers, 1957.
A Trip to Grandmother's, Clare Whitbeck, et al. Department of Transportation, Federal Aviation Administration, Washington, D.C. 20590.
Peter and the Moon Trip, Hazel Corson. Pub. by Benefic, 1955.

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Canby, Courtlandt, *A History of Rockets and Space*. New York: Hawthorne, 1963.
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Gibbs-Smith, C. H., *A History of Flying*, New York: Praeger, 1954.
Goddard, Robert H., *Rocket Development*, New York: Prentice-Hall, 1961.
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Gray, George W., *Frontiers of Flight*, New York: Alfred Knopf, 1948.
Hoyle, Fred, Astronomy: *A History of Man's Investigation of the Universe*.
Lear, Joh, *Kepler's Dream*, Berkeley: University of California Press, 1965.
Matz, Lloyd, *This is Outer Space*, Archer House, Inc., New York: 1960.
Lewellen, John, *The Story of Flight*, New York: Golden Press, Inc., 1959.
Milbank, J., *The First Century of Flight in America*, Princeton: Princeton University Press, 1943.

Shrader, W. . *Fifty Years of Flight*, 1903-1953, Cleveland: Eaton, 1953.

Turnbull, A. D. and C. L. Lord, *History of U. S. Naval Aviation*, New Haven: Yale University Press, 1949.

Warner, Edward P., *Early History of Air Transportation*, Northfield, Vermont: Norwich University Press, 1937.

Zaffo, George J., *The Book of Airplanes*, New York: Grossett and Dunlap, Inc., 1966.

Asimov, Isaac, *The Moon*, Follett, 1966.

Branley, Franklin, *A Book of Planets for You*, Crowell, 1966.

Kiefer, Mildred S., *Planet X*, Melmont, 1965.

May, Julian, *Rockets*, Follett, 1967.

Shapp, Martha and Charles, *Let's Find Out About the Moon*, Watts, 1965.

Sonneborn, Ruth A., *The Question and Answer Book of Space*, Random, 1965.

Victor, Edward, *Planes and Rockets*, Follett, 1965.

FAA, Aviation Education
GA-20
Washington, D.C. 20590
(A self-addressed gummed label should accompany each request)

FAA — Publications

a. Demonstration Aids for Aviation Education (For teachers only)
b. "Teaching Guide for an Aerospace Communication Lab" (For teachers only)
c. "Aerospace Units for Elementary Science Classes:—Grades 2 and 3 (For teachers only)
d. "A Flight to Grandmother's"—Scripts and illustrations are taken from filmstrip.

NASA — Publications

The following NASA materials are available through the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402

Model Spacecraft Construction
b. Introducing Children to Space — The Lincoln Plan
c. Space Resources for Teachers — Biology
d. The Spaces of Tomorrow
e. What's Up There

All the following materials can be obtained by writing to:
Educational Programs Division, NASA Headquarters, Washington, D.C.

a. Educational Guidance in the Space Age
b. Science Education in the Space Age
c. The Planetarium — an elementary — school teaching resource
d. Space Science
e. Aerospace Curriculum Resource Guide
f. Life Science in a Space Age Setting
g. A Universe to Explore
h. Space Resources for the High School

Encyclopedia

Above and Beyond
New Horizons Publishers
14 volumes plus Teacher's Guide
1968

Exploring Space
World Book Encyclopedia Guide for Teachers
Field Enterprises Education Corporation
Chicago, Illinois

Teaching Aids:

You and Space (Supplementary reader)
Natural Aerospace Educational Council
Room 616, 806-15th Street, N.W.
Washington, D.C.